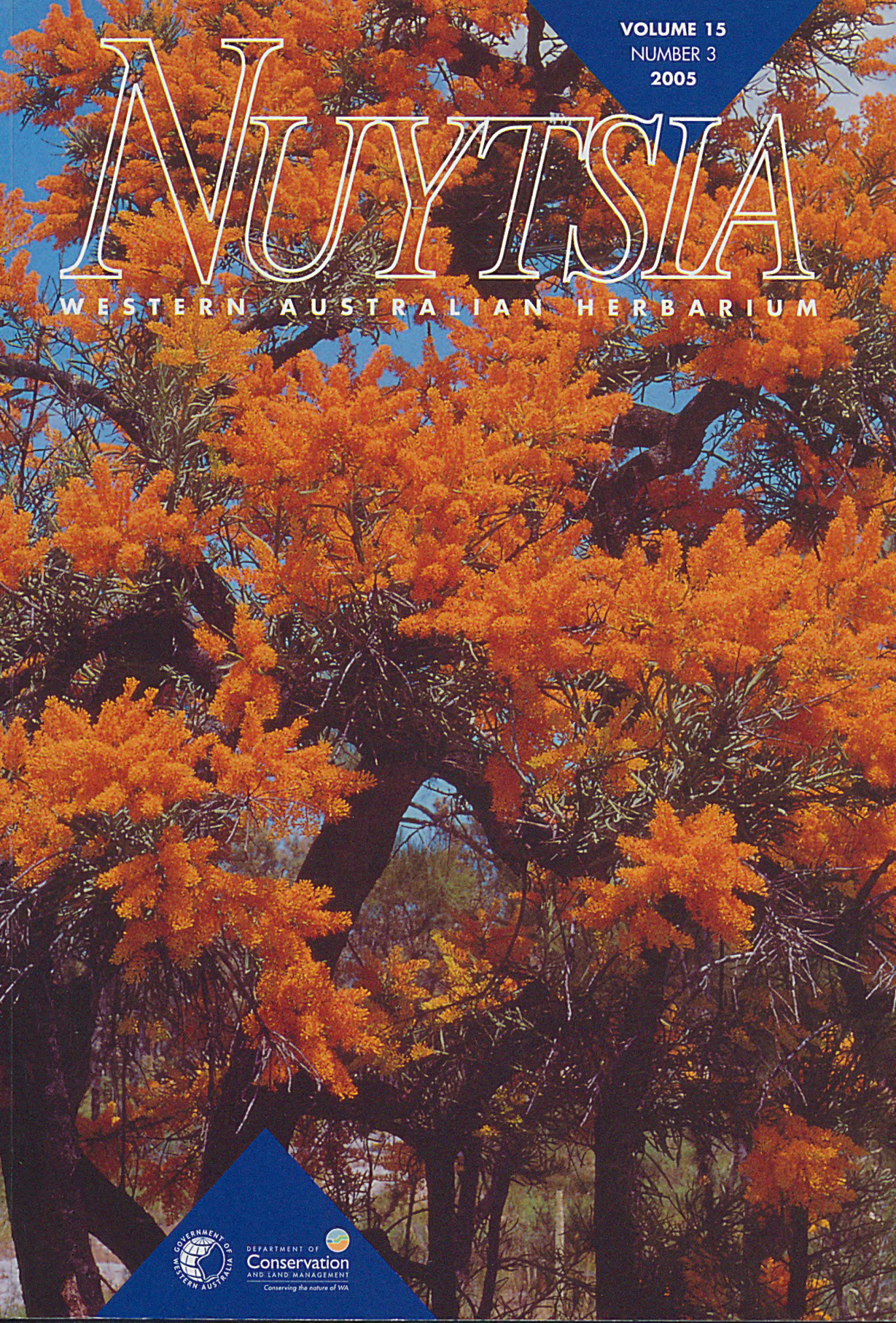
VOLUME 15
NUMBER 3
2005

NUYTSIA

WESTERN AUSTRALIAN HERBARIUM



GOVERNMENT OF WESTERN AUSTRALIA
DEPARTMENT OF Conservation AND LAND MANAGEMENT
Conserving the nature of WA

Cover

Nuytsia floribunda (Labill.) R. Br. ex Fenzl (Loranthaceae) – the Western Australian Christmas tree – is one of the few arborescent mistletoes in the world. This endemic tree is a semi-parasite common in sandy soil from the Murchison River to Israelite Bay. The journal is named after the plant, which in turn commemorates Pieter Nuijts, an ambassador of the Dutch East India Company, who in 1627 accompanied the 'Gulde Zeepard' on one of the first explorations along the south coast of Australia.

Photograph A.S. George

NUYTSIA

VOLUME 15 NUMBER 3 2005

Western Australian Herbarium
Department of Conservation and Land Management
Western Australia

Nuytsia

Nuytsia publishes original papers on systematic botany with preference given to papers relating to the flora of Western Australia.

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Published by the Department of Conservation and Land Management, Locked Bag 104, Bentley Delivery Centre, WA 6983.

ISSN 0085-4417

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Two new species of *Brachyloma* (Epacridaceae) from the South West Botanical Province of Western Australia

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Abstract

Cranfield, R. J. Two new species of *Brachyloma* (Epacridaceae) from the South West Botanical Province of Western Australia. *Nuytsia* 15(3): 331–336(2005). Endemic to the South West Botanical Province of Western Australia, *Brachyloma delbi* Cranfield and *Brachyloma mogin* Cranfield are described, illustrated and mapped.

Introduction

Brachyloma is an Australian genus of eight known species of which five occur in eastern Australia. In Western Australian *Brachyloma* prior to 1998 consisted of only two recognised species, *Brachyloma concolor* Benth. and *Brachyloma preissii* Sonder. These western taxa are closely allied to *Brachyloma ericoides* Sond., a common South Australian and Victorian species. The two Western Australian species and *B. ericoides* form *Brachyloma* section *Brachyloma* Sond. while the remaining four eastern taxa constitute the section *Lissanthoides* Benth. (Bentham 1869).

In 1998 a third Western Australian species, *Brachyloma gnuba* Cranfield was described from material collected by the author. During the 1998 study the need for further revisionary work was recognised but not progressed as it was considered that not enough material existed at the time to satisfactorily support the recognition of the following two new species.

A specimen of *Brachyloma* collected by a Kulin Regional Herbarium collector in May 1995 was found to be different from the known Western Australian species. Detailed examination of this material showed characters that suggested that this was a new species. A subsequent search of herbarium specimens (PERTH) failed to locate any other collections. The original collector was approached and a further three collections were made in 1999 from the Kulin area.

A second undescribed collection of *Brachyloma* was recognised while checking PERTH herbarium records. Attempts to locate additional material of this second new taxon led to a successful collection being made in May 1997. Both of the new species appear to be more closely related to *Brachyloma concolor* Benth. than *Brachyloma preissii* Sonder and they both conform to *Brachyloma* section *Brachyloma*. These two new species of *Brachyloma* will enlarge the genus to 10 species.

Methods

Two or three flowers were dissected from each of the new species and the same number of flowers from selected sheets representing the existing known Western Australian species to establish character differences. All the *Brachyloma* material held in herb. PERTH was examined. Other members of the family were also examined in an attempt to locate additional specimens of the new species. All floral characters were measured either by ruler, measuring lens or with a stereo microscope eye-piece micrometer. Measurements were made to encompass a range of sizes but exclude the obvious extremes such as juvenile or underdeveloped characters.

Taxonomy

Diagnostic characters for the new Western Australian species of *Brachyloma* are given in Table 1. The shape of the style distinguishes these new species from each other and the measured leaf characters separated them from the other known Western Australian species. *Brachyloma delbi* has a similar style shape to *Brachyloma nguba* Cranfield but can be separated by leaf characters.

The two species are also geographically disjunct. Habitat difference further segregates these species, with *B. delbi* occurring in open woodland with gravel soil while *B. nguba* occurs in an open mallee woodland-mallee scrub over white to brown sandy clay.

Table 1. Characters distinguishing the two new species of *Brachyloma*.

Character	*B. delbi*	*B. mogin*
Leaf		
length (mm)	4.0–8.0	6.0–10
width (mm)	0.75–1.0	1.5–2.0
cross section	revolute	flat–convex
apex	apiculate	acute
mucro length (mm)	0.25–0.5	0.5–1.0
Flower		
pedicel length (mm)	0.75–1.0	1.0–1.5
sepal length (mm)	1.5–2.0	2.0–2.25
style length (mm)	0.25–0.75	0.5–1.0
ovary locules	4	4,5

Brachyloma delbi Cranfield, *sp. nov.*

Brachyloma preissii similis sed foliis revolutis stylo breviore 0.25–0.75 mm (versus 1–1.5 mm) et habito elatiore differt.

Typus: Kulin [precise locality withheld], Western Australia, May 1995, *S. Murray* KKS 181 (*holo*: PERTH 04612094).

Shrub to 1.5 m high. *Branchlets* sparsely setulose. *Leaves* alternate on branchlets, erect; petiole 0.5–1.0 x 0.25 mm; lamina linear, 4.0–8.0 x 0.75–1.0 mm, sparsely setulose to glabrous adaxially, setulose abaxially, with numerous prominent veins; margins revolute; apex apiculate, 0.25–0.5 mm long. *Inflorescence* of solitary axillary flowers in terminal leaf clusters. *Pedicels* 0.75–1.0 mm long; bracteoles 5–8, sessile, imbricate, 0.5–0.75 x 0.25–0.75 mm, margin fringed, apex acute; bracts 2, sessile, 0.9–1.0 x 1.0–1.1 mm, margin fringed, apex obtuse. *Sepals* ovate, 1.5–2.0 x 1.0–1.5 mm; margin fringed to glabrous; apex obtuse. *Corolla* pink to red; urceolate, 3.0–4.5 x 2.5–3.0 mm; throat partially constricted below corolla lobes, base slightly constricted; reflexed scales 0.25–0.5 mm long, with long hairs on apex; corolla lobes erect to spreading, broadly triangular, 1.0 x 1.0 mm, acute. *Stamens* 5, partially visible at base of corolla lobes, antesepalous; anthers linear, 1.0–1.5 x 0.25–0.5 mm. *Hypogynous disc* truncate to slightly lobed, *c.* 0.25 mm high. *Ovary* glabrous, 1.0–1.1 x *c.* 1.0 mm, 4-locular, ovules 1 per locule; white, *c.* 0.5 mm long, elliptic; *style* broad and only partially differentiated from the ovary, 0.25–0.75 mm long, with 3–4 small rounded apical lobes. *Fruit* a globular drupe, 3–4 mm, slightly angular, glabrous with persistent style. (Figure 1 A–C)

Other specimen examined. WESTERN AUSTRALIA: Kulin, Apr. 1999, *D.E. Murfet* 3528, 3518, 3527.

Distribution. Known only from the type location. (Figure 2)

Habitat. Open woodland with gravel soil.

Flowering time. April–May.

Conservation status. Conservation Codes for Western Australian Flora: Priority 1. This species is from a threatened location and only known from a few collections, occuring within the extensively cleared eastern wheatbelt. All known populations of this species appear to occur within the Kulin town boundaries and as such are under potential threat. Further field surveys are required for this species before its conservation status can be fully assessed.

Etymology. The specific epithet is from the Nyoongar aboriginal word 'delbi' meaning leaf (Bindon & Chadwick 1992), referring to the fact that the leaves of this species are characteristic.

Notes. The type specimen of *Brachyloma delbi* was previously placed under *Brachyloma concolor* Benth. at PERTH, although this was not considered an accurate determination. The small size of the flowers, style shape, revolute leaf margins and reduced apex mucro indicated a closer affinity to *Brachyloma nguba* (Cranfield, 1998). *Brachyloma delbi* is distinguished from *Brachyloma nguba* by its longer and narrower leaves.

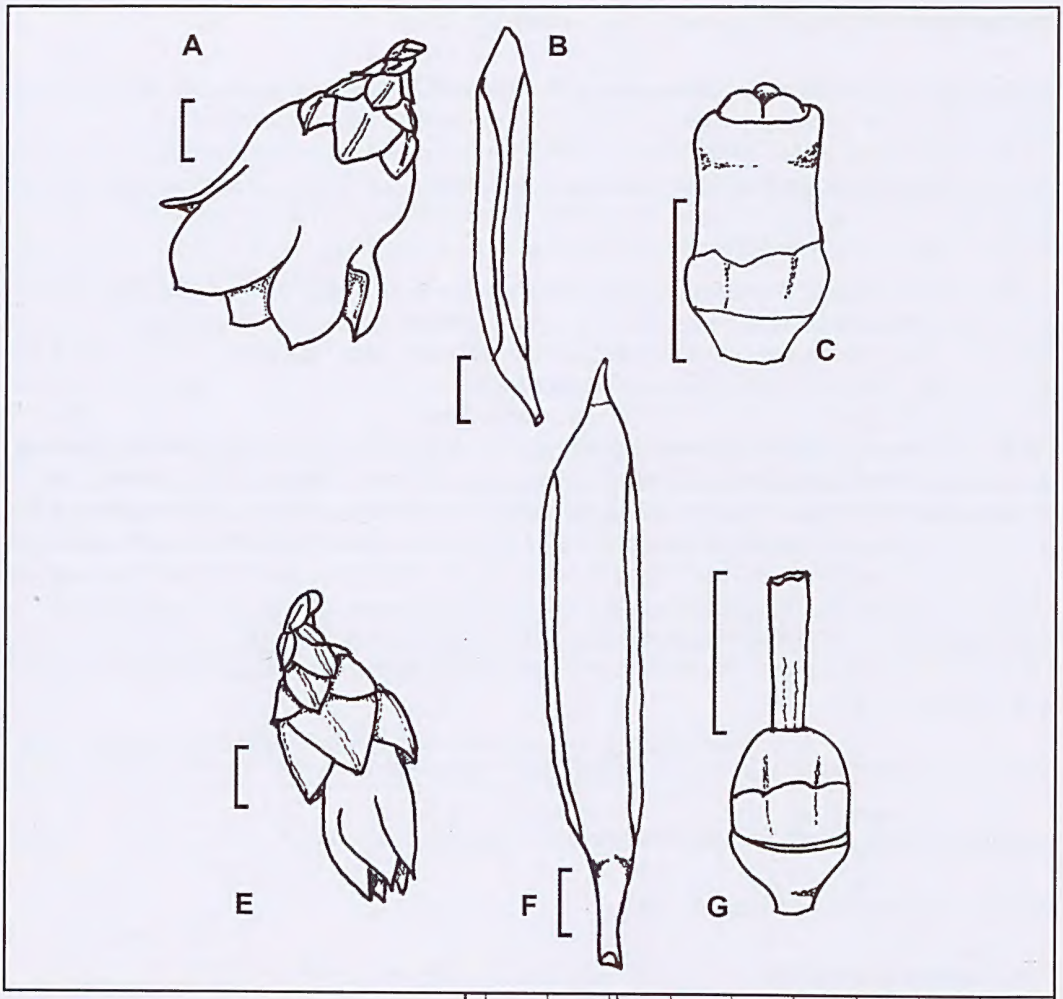

Figure 1. A–C: *Brachyloma delbi*, A – flower; B – leaf underside; C – style. E–G: *Brachyloma mogin*, E – flower; F – leaf underside; G – style. Scale bar = 1mm.

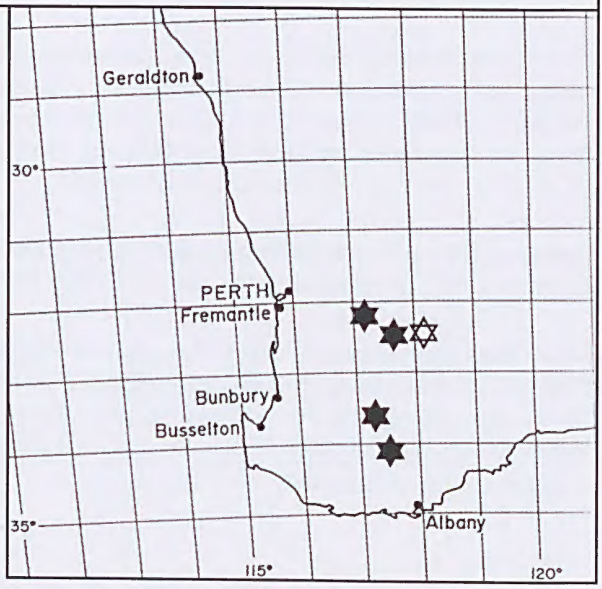

Figure 2. Distribution of *Brachyloma delbi* ✡ and *Brachyloma mogin* ✶

Brachyloma mogin Cranfield, *sp. nov.*

Brachyloma delbi affinis sed stylo longiore et foliis latioribus differt.

Typus: 28.5km W of Katanning (33° 41'07" S, 117° 14'08" E), Western Australia, May 1997, *R.J. Cranfield* 11372 (*holo*: PERTH 04751795; *iso*: CANB, PERTH 04751809).

Shrub to 80 cm high. *Branchlets* hispid. *Leaves* alternate on branchlets, erect; petiole 0.5–1.0 x 0.25–0.5 mm; lamina linear–lanceolate, 4.0–10 x 1.25–2.0 mm, glabrous adaxially, hispid abaxially, with numerous prominent veins; margins flat to convex; apex acute, 0.5–1 mm long. *Inflorescence* of solitary axillary flowers in terminal leaf clusters. *Pedicels* 1.0–1.5 mm long; bracteoles 5, sessile, imbricate, 0.5–0.75 x 0.75–1.0 mm, margin ciliate, apex obtuse; bracts 2, sessile, 1.5 x 1.0 mm, margin ciliate and apex obtuse to acute. *Sepals* ovate to obovate, 2.0–2.25 x *c.* 1.5 mm; margin fringed; apex obtuse. *Corolla* red to pink, urceolate, 4.0–5.0 x 2.0–3.0 mm; throat partially constricted below corolla lobes with an inflated base, reflexed scales 0.3–0.4 mm long, with long hairs on apex; corolla lobes erect or reflexed with age, triangular, 1.5–3.0 x 1.0–1.5 mm, acute. *Stamens* 5, partially visible at base of corolla lobes, antesepalous, anthers linear, 1.0–1.25 x *c.* 0.5 mm. *Hypogynous disc* truncate to partially 5 lobed, *c.* 0.5 mm high. *Ovary* glabrescent, 0.5–1.0 x 0.5–1.0 mm, 4 or 5 locular, ovules 1 per locule; white, *c.* 0.25 mm long, elliptic; *style*, linear, clearly differentiated from the ovary, 0.5–1.0 mm long, with 5 small triangular apical lobes. *Fruit* a compressed, globular drupe 3–4 mm long, glabrous, with a persistent style. (Figure 1 E–G)

Other specimens examined. WESTERN AUSTRALIA: Boyagin Reserve, July 1977, *A.S. George* 14609 (PERTH); Kunjin Reserve [W of Corrigin], July 1999, *R. Campbell s.n.*; Corrigin, May 2000, *K. Kershaw* KK2086; NE of Brookton, October 1979, *R.J. Hnatiuk* 790174.

Distribution. Endemic to the Jarrah Forest and the Avon Wheatbelt IBRA Regions (Thackway and Cresswell 1995) in the South West Botanical Province of Western Australia. This species is known from several locations. (Figure 2)

Habitat. Open woodland over grey sandy clay in areas that become inundated in winter.

Flowering time. May to June.

Conservation status. This species is known from several populations occurring on nature reserves. Conservation Codes for Western Australian Flora: Priority 3.

Etymology. The specific epithet is from the Nyoongar aboriginal word 'mogin' meaning 'similar to' (Bindon & Chadwick 1992), referring to the close similarity to *Brachyloma delbi*.

Notes. Brachyloma mogin has a close affinity to *Brachyloma delbi* but has larger flowers and a distinctive style morphology. Further collections will help to provide a better understanding of this species and its relationship to *Brachyloma concolor* Benth.

Acknowledgment

The Latin diagnoses were kindly prepared by Mr Paul G. Wilson.

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Further new taxa in *Dryandra* R. Br. (Proteaceae: Grevilleoideae)

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Abstract

George, A.S. Further new taxa in *Dryandra* R.Br. (Proteaceae: Grevilleoideae). *Nuytsia* 15(3): 337–346 (2005). The following new taxa in *Dryandra* are described: *D. prionotes* A.S. George, *D. ferruginea* subsp. *magna* A.S. George, *D. fraseri* var. *crebra* A.S. George, *D. fraseri* var. *effusa* A.S. George, *D. ionthocarpa* subsp. *chrysophoenix* A.S. George and *D. pteridifolia* subsp. *inretita* A.S. George.

Introduction

Since the publication of the account of *Dryandra* in "Flora of Australia" (George 1999), research in the genus has continued, assisted by new collections. A new species (discovered early in 2002) and five new infraspecific taxa are described here. A number of variants that may represent further new taxa await collection of further material for study. These include specimens related to *D. borealis* A.S. George, *D. conferta* Benth., *D. ferruginea* Kippist ex Meisn., *D. nivea* (Labill.) R. Br., *D. plumosa* R. Br. and *D. pteridifolia* R. Br. The series *Niveae* Benth., in particular, would make a good topic for a PhD. Several new presumed hybrids have also been discovered, e.g. one between *D. longifolia* subsp. *archeos* A.S. George and *D. armata* var. *ignicida* A.S. George.

Taxonomic concepts adopted here for the ranks of species, subspecies and variety remain the same as those adopted in the author's previous papers, e.g. George (1991), George (1996). The format and terminology for descriptions follow those explained in "Flora of Australia" 17B: 252 (1999). The term "kwongan" was proposed by Beard (1976) as an indigenous term for the sclerophyllous shrublands of south-western Australia, comparable with the maquis, chaparral and fynbos of the Mediterranean, California and South Africa, respectively. Since all taxa described here are rare, precise locality details have been withheld for conservation reasons. Distributions of the new taxa are mapped (Figure 2).

Taxonomy

Dryandra ferruginea Kippist ex Meisn., *Hooker's J. Bot. Kew Gard. Misc.* 7: 123 (1855). Type: south-western Western Australia, late 1840s, *J. Drummond* 5: 416 (*syn*: BM, CGE, K, NY).

Dryandra ferruginea subsp. **magna** A.S. George, *subsp. nov.*

Ab *Dryandra ferruginea* subsp. *tutanningensis* A.S. George lobis foliorum marginibus revolutis, bracteis inflorescentiae pubescentibus, et folliculis minoribus (9–11 mm longis), differt.

Typus: N of Nyabing, Western Australia, 33° 30' S, 118° 08' E, 30 July 1986, *A.S. George* 16699 (*holo*: PERTH 03462390; *iso*: K, MEL).

Shrub to 1.5 m high without lignotuber. *Leaves* broadly linear; lamina 10–30 mm wide; lobes spreading or ascending, narrowly triangular; margins revolute. *Involucral bracts* 70–80 mm long, pubescent outside, the upper margins sometimes lacerated; *floral bracts* 10–12 mm long, elongating to *c.* 15 mm in fruit. *Perianth* 44–53 mm long; limb 10–13 mm long. *Pistil* 43–62 mm long; pollen presenter 7–10 mm long. *Follicles* 9–11 mm long.

Specimens examined. WESTERN AUSTRALIA: Manuel Rd, E of junction with Nyabing South Rd, 30 July 1986, *A.S. George* 16696 (PERTH); Wedin Rd South, 19 Sept. 1999, *G. Warren, C. Taylor & P. Rose* 456 (PERTH).

Distribution. Western Australia, near Nyabing and north of Dumbleyung.

Habitat. Yellow-grey sandy gravel over laterite, or gravelly loam, in tall shrubland, sometimes with mallee eucalypts.

Flowering period. July and August.

Conservation status. CALM Conservation Codes for Western Australian Flora: Priority One.

Etymology. The epithet *magna* refers to the size of the inflorescence.

Affinities. This appears most similar to *D. ferruginea* subsp. *tutanningensis* A.S. George in having a large inflorescence (involucral bracts 7–8 cm long) but differs in the wholly pubescent involucral bracts and the more strongly revolute leaf margins. The few follicles seen are smaller than those of subsp. *tutanningensis*. The known populations are disjunct and are all on road verges in the agricultural region. The plants are non-lignotuberous, hence are vulnerable to disturbance such as fire and weed encroachment.

The subspecies of *D. ferruginea* may be keyed out as follows.

1. Stems erect
  2. Leaf lobes ascending at *c.* 70°–80°
    3. Involucral bracts 70–80 mm long (near Nyabing, Dumbleyung) ..... subsp. **magna**
    3. Involucral bracts 30–66 mm long
      4. Pistil 50–66 mm long; involucral bracts 50–66 mm long (SE of Pingelly, E of Quairading) ..... subsp. **tutanningensis**
      4. Pistil 30–45 (50) mm long; involucral bracts 30–50 mm long, rarely longer
        5. Leaf lamina 15–35 cm long, 10–28 (–40) mm wide; lobe margins revolute (Wickepin to Nyabing and Lake Grace) ..... subsp. **ferruginea**
        5. Leaf lamina 8–15 cm long, 18–35 mm wide; lobe margins almost flat (Stirling Ra.) ..... subsp. **pumila**
  2. Leaf lobes ascending at *c.* 60°–70° (Corrigin area) ..... subsp. **obliquiloba**
1. Stems prostrate
  6. Leaves 20–45 mm wide; lobes usually falcate, sometimes reflexed (Newdegate–Ravensthorpe) ..... subsp. **chelomacarpa**
  6. Leaves 7–15 mm wide; lobes triangular, at *c.* 90° (E of Lake King) ..... subsp. **flavescens**

Dryandra fraseri R. Br., *Suppl. Prodr. Fl. Nov. Holl.* 39 (1830). Type: Swan River, [Western Australia], 1827, *C. Fraser* (*holo*: BM; *iso*: K).

Dryandra fraseri R. Br. var. **crebra** A.S. George, *var. nov.*

Ab *Dryandra fraseri* R. Br. var. *fraseri* habitu humiliori plerumque effuso, foliis brevioribus, lobis brevioribus, crebris, floribus plerumque minoribus (pistillo 25–30 mm longo) differt; et ab var. *effusa* A.S. George lobis foliorum linearibus glaucis differt.

Typus: First North Rd, N of Three Springs–Eneabba Rd, Western Australia, 29° 42' S, 115° 21' E, 6 Aug. 1986, *A.S. George* 16805 (*holo*: PERTH 04562623; *iso*: MEL).

Shrub usually less than 50 cm high. *Leaves* commonly less than 5 cm long; lobes linear, crowded (1–3 mm apart), mostly less than 8 mm long, glaucous; margins revolute. *Involucral* bracts glabrous to shortly pubescent in lower half, with very dark indumentum towards apex. *Perianth* sparsely to densely hirsute above base. *Pistil* 25–30 mm long. (Figure 1A)

Selected specimens examined. WESTERN AUSTRALIA: Jurien Bay Rd, 29 Aug. 1938, *W.E. Blackall* 3675 (PERTH); Breakaway Farm, 29 July 1995, *M. Hislop* 51 (PERTH); W of Three Springs on Eneabba Rd, 6 Aug. 1986, *M. Pieroni* 21 (PERTH).

Distribution. Western Australia, between Badgingarra and a short distance north-east of Eneabba.

Habitat. Sandy loam or sandy clay over laterite, in kwongan.

Flowering period. July and August.

Conservation status. CALM Conservation Codes for Western Australian Flora: Priority Three.

Etymology. From the Latin *crebrus*, crowded, in reference to the leaf lobes.

Affinities. The low habit, short leaves and crowded linear leaf lobes give this taxon a distinctive aspect. In its indumentum the perianth resembles var. *fraseri* rather than the two other varieties.

Dryandra fraseri var. **effusa** A.S. George, *var. nov.*

Ab *Dryandra fraseri* R. Br. var. *fraseri* habitu humiliori plerumque effuso, et foliis brevioribus, lobis brevioribus, crebris, differt; et ab var. *crebra* A.S. George lobis foliorum anguste triangularibus differt.

Typus: NE of Mt Lesueur, Western Australia, *c.* 30° 09 'S, 115° 09' E, 3 July 1998, *A.S. George* 17420 (*holo*: PERTH 06037984; *iso*: K, MEL, NSW).

Shrub usually less than 50 cm m high. *Leaves* commonly less than 6 cm long; lobes narrowly triangular, commonly less than 7 mm long, crowded; margins revolute. *Involucral* bracts finely and closely pubescent, the indumentum towards apex very dark. *Perianth* hirsute above base, pink or cream; limb green or cream. *Pistil* 27–34 mm long. (Figure 1B)

Other specimen examined. WESTERN AUSTRALIA: Mt Lesueur Natl Park, 9 Aug. 1996, *Bill Evans* (PERTH).

Distribution. Western Australia, near Mt Lesueur.

Habitat. Lateritic clay–loam, in kwongan.

Flowering period. July and August.

Conservation status. CALM Conservation Codes for Western Australian Flora: Priority Two.

Etymology. From the Latin *effusus* (spread out, sprawling), in reference to the growth habit.

Affinities. Plants referable to this variant were mentioned in the discussion under *D. fraseri* var. *fraseri* in *Flora of Australia* 17B: 285 (1999), although the length of the leaf lamina given there (5–10 cm) and that of the pistil (30–42 mm) erroneously excluded them. Like var. *crebra*, var. *effusa* has consistently shorter leaves than the varieties described therein. It is similar to var. *crebra* in the low, sprawling habit but is distinguished by the narrowly triangular leaf lobes that leave the undersurface exposed. The foliage lacks the blue tinge of var. *crebra*.

The circumscription of the species should now be amended to take into account the length of the leaf lamina and pistil in these two varieties. The varieties of *D. fraseri* may be keyed out as follows.

1. Perianth claws pubescent to hirsute
   2. Shrub usually 50–150 cm tall; leaf lamina usually 8–10 cm long, the lobes openly spaced (sinus commonly 3–5 mm wide); pistil 30–37 mm long ..... var. **fraseri**
   2. Shrub usually less than 50 cm tall; leaf lamina less than 6 cm long, the lobes closely crowded (sinus commonly 1–3 mm wide); pistil 27–34 mm long
      3. Leaf lobes linear, glaucous ..... var. **crebra**
      3. Leaf lobes narrowly triangular, green ..... var. **effusa**
1. Perianth claws glabrous or sparsely pubescent
   4. Pistil 30–35 mm long; sprawling shrub to 1 m, with lignotuber ..... var. **ashbyi**
   4. Pistil 38–42 mm long; erect shrub to 6 m, without ligntouber ..... var. **oxycedra**

Dryandra ionthocarpa A.S. George, *Nuytsia* 10: 376 (1996). Type: near Kamballup, Western Australia, 34° 35' S, 117° 59' E, 11 Oct. 1988, *P. Luscombe s.n.* (*holo*: PERTH 03462099; *iso*: AD, CANB, K, MEL, NSW, PERTH 03462102).

Two more populations of this species have been discovered east of Brookton and further material collected. They differ from the Kamballup population in having a lignotuber and in some foliar and floral details and are here described as a new subspecies.

1. Plant non-lignotuberous; margins of leaf lobes gently curved; perianth 39–43 mm long; pistil 43–44 (–57) mm long ..... subsp. **ionthocarpa**
1. Plant lignotuberous; margins of leaf lobes almost straight; perianth 52–60 mm long; pistil 63–65 mm long ..... subsp. **chrysophoenix**

Dryandra ionthocarpa A.S. George subsp. **ionthocarpa**

Shrub without lignotuber. Margins of *leaf lobes* gently curved. *Floral bracts* 5–6 mm long, apparently not elongating in fruit. *Perianth* 39–43 mm long including limb 7–8 mm long; claws pink–mauve; limb pale yellow. *Pistil* 43–44 (–57) mm long; pollen presenter 3.5–4.8 mm long. *Follicles* obovate, 5–6 mm long, with an apical tuft of hairs, otherwise glabrous. (Figure 1C)

Distribution. Western Australia, near Kamballup.

Habitat. Spongolitic gravel, in kwongan.

Flowering period. September and October.

Conservation status. CALM Conservation Codes for Western Australian Flora: Priority Two.

Dryandra ionthocarpa subsp. **chrysophoenix** A.S. George, *subsp. nov.*

Ab *Dryandra ionthocarpa* A.S. George typica habitu lignotubero, perianthio longiore (52–60 mm longo) et pistillo longiore (63–65 mm longo), praecipue differt.

Typus: near Aldersyde, Western Australia, 32° 22' S, 117° 16' E, 23 Oct. 1999, *M. Pieroni* 99/15 (*holo*: PERTH 06406289; *iso*: K, MEL, NSW).

Shrub with lignotuber, apparently clonal. Margins of *leaf lobes* almost straight. *Floral bracts* c. 4 mm long, elongating to 6–7 mm in fruit. *Perianth* 52–60 mm long including limb 6–11.5 mm long; claws purple–red; limb golden. *Pistil* 63–65 mm long; pollen presenter 3–5.5 mm long. *Follicles* (not seen mature) obovate, 9–11 mm long, tomentose on stylar edge, as well as having the prominent apical tuft characteristic of the species. (Figure 1D)

Selected specimens examined. WESTERN AUSTRALIA: Kalvedon Rd, E of Aldersyde Rd, *K. Kershaw* 2310 (PERTH); Jingaring Reserve, *F. Obbens, R. Davis & L. Sage* FO335/98, 8 Dec. 1998 (PERTH).

Distribution. Western Australia, known from three populations east of Brookton.

Habitat. Brown or white sandy loam over laterite or granite, in kwongan, sometimes with scattered *Allocasuarina huegeliana*.

Flowering period. July and August.

Conservation status. CALM Conservation Codes for Western Australian Flora: Priority Three.

Etymology. From the Greek *chryso–* (golden) and *phoinix* (purple–red), in reference to the striking combination of gold and purple in the perianth; *phoinix* also referring to the plant's ability to sprout from its rootstock after fire, just as the fabled phoenix could arise from its own funeral pyre. The Latinised form *phoenix* is preferred for the botanical epithet.

Affinities. This is closely allied with *Dryandra ionthocarpa* in all aspects of its morphology, differing

mainly in having a fire-tolerant rootstock. The margins of the leaf lobes are straighter than those of subsp. *ionthocarpa*. Generally its flowers are larger than those of typical *D. ionthocarpa*, but several collections of the latter have large flowers. It appears to set mature fruit very rarely, examination of the plants showing only a few follicles that appeared to be immature. The account of *D. ionthocarpa* in "Flora of Australia" vol. 17B stated that the floral bracts do not elongate as the fruit develops, but that may not be the case as some elongation was noted in subsp. *chrysophoenix*.

Dryandra prionotes A.S. George, *sp. nov.*

Ab *Dryandra armata* R. Br. foliis longioribus (9–15 cm longis), rectis, dentibus pluribus (10–18 in quoque margine), inferus lanatis, perianthio limbo incluso hirsutioribus, et fructu majore, praecipue differt.

Typus: S of Cataby Roadhouse, Brand Hwy, Western Australia, c. 30° 47' S, 115° 35' E, 16 July 2002, *A.S. George* 17599, *M. Pieroni, F. & J. Hort* (*holo*: PERTH 06406297; *iso*: K, MEL, NSW).

Shrub 50–70 cm m high with lignotuber. *Leaves* erect, broadly linear, somewhat channelled, 9–15 cm long, 12–18 mm wide; lamina glabrous above except some short curled hairs along midrib, woolly below; lobes 10–18 each side, curved–triangular; margins shortly recurved; petiole 5–10 mm long. *Inflorescence* terminal, subtended by a few reduced leaves; involucral bracts narrowly ovate (outer) grading to oblong, the largest 22–24 mm long, closely hirsute, pale brown; receptacle slightly convex; flowers *c.* 60 per head. *Floral bracts* lanceolate, obtuse, 7–8 mm long, glabrous except pubescent upper part. *Perianth* 29–32 mm long, ± straight; claws pinkish, densely hirsute; limb 6–6.5 mm long, almost glabrous at apex, green at base, pink towards apex. *Pistil* 36–38 mm long, ± straight, hirsute in lower half; pollen presenter 3–3.5 mm long, not thickened, faintly ribbed; hypogynous scales narrowly ovate–oblong, *c.* 1.5 mm long. *Follicles* ovate–oblong, 13–16 mm long, with scattered long hairs; floral bracts enlarging to 13–15 mm long in fruit, lanceolate in upper half, with scattered hairs. (Figure 1E–G)

Selected specimens examined. WESTERN AUSTRALIA: type locality, 10 Oct. 2001, *F.& J. Hort* (PERTH); type locality, 7 July 2002, *F.& J. Hort* and *M. Pieroni* (PERTH).

Distribution. Western Australia, known from one population south of Cataby, Brand Hwy.

Habitat. A lateritic rise, in low kwongan.

Flowering period. July and August.

Conservation status. CALM Conservation Codes for Western Australian Flora: Priority One.

Etymology. The Greek *prion–* (saw–) with the suffix *–otes* (denoting quality) refers to the leaf margins.

Affinities. This is closely related to *Dryandra armata* R. Br., a widespread, variable species. The longer, erect leaves with a woolly lower surface give it a distinctive aspect (always spreading in *D. armata*), the perianth is more hairy, and the follicle is larger. The floral bracts are larger at flowering and are pubescent in the upper half but do not lengthen to the same degree as those of *D. armata* (4–7 mm at flowering, c. 17 mm at fruiting, glabrous). There is a single population of about 70 plants of *D. prionotes*. *Dryandra armata* var. *armata* occurs in surrounding districts. In the 2002 season, when the type was collected, almost all inflorescences were damaged by insects.

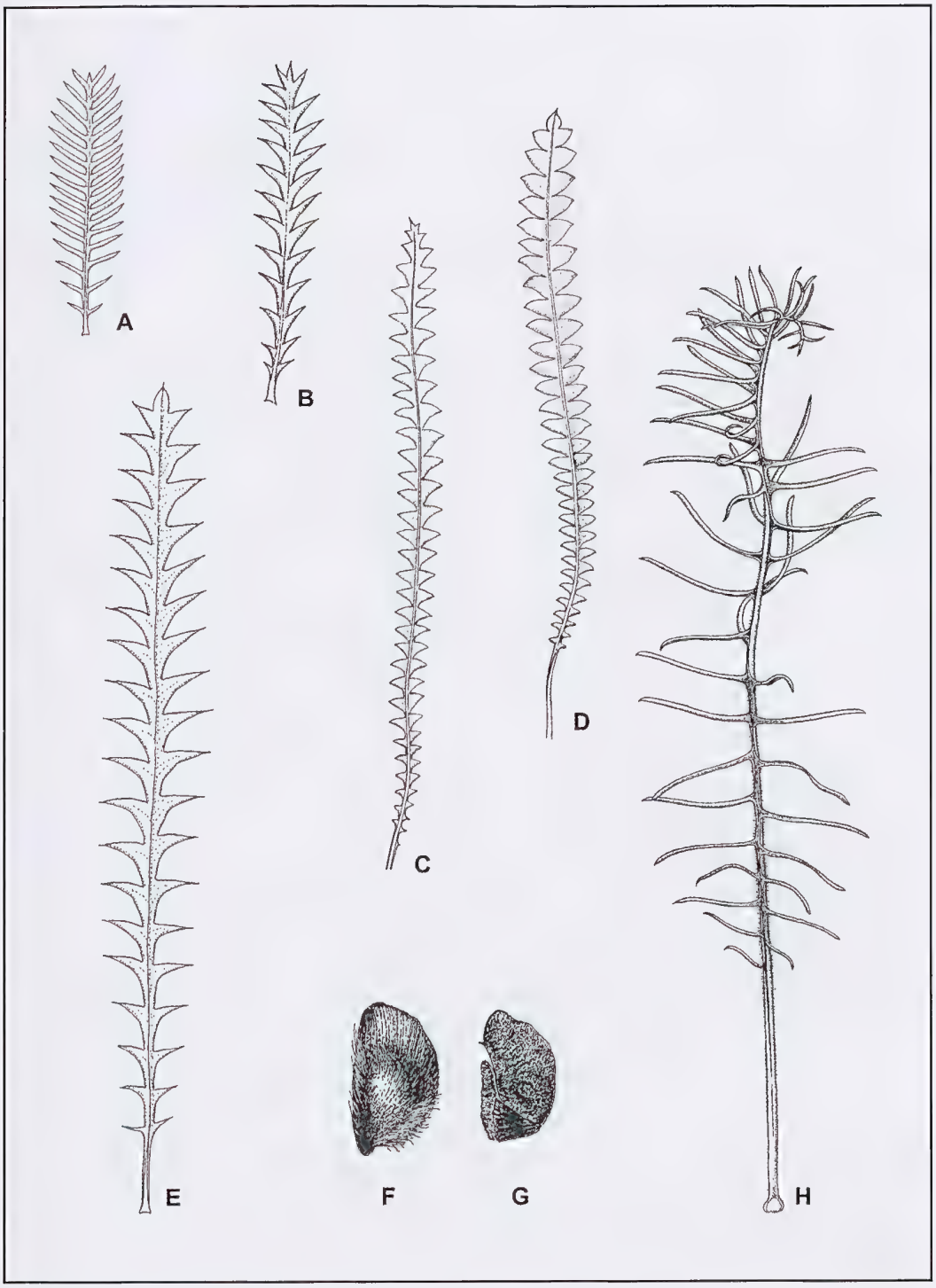

Figure 1. A – *Dryandra fraseri* var. *crebra*, leaf ×1. B – *Dryandra fraseri* var. *effusa*, leaf ×1. C–D *Dryandra ionthocarpa*, leaves ×0.5; C – subsp. *ionthocarpa*; D – subsp. *chrysophoenix*. E–G *Dryandra prionotes*, E – leaf ×1; F, follicle ×2; G – seed ×2. H – *Dryandra pteridifolia* subsp. *inretita*, leaf ×0.5.

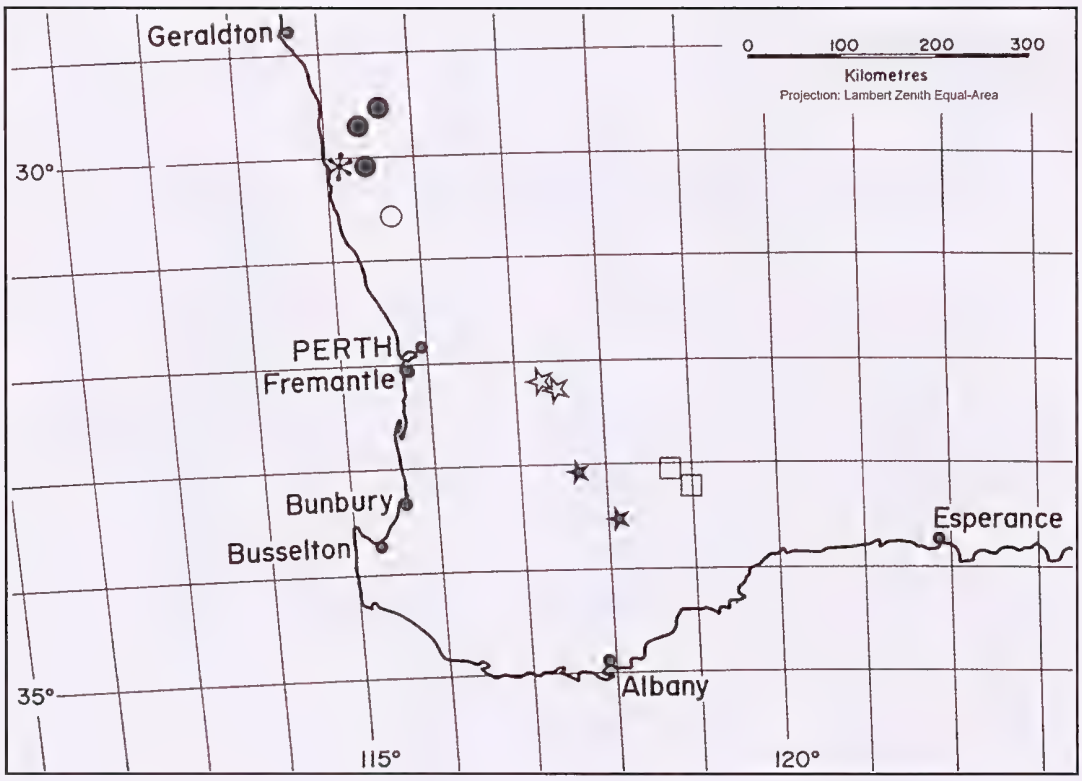

Figure 2. Distribution of *Dryandra* taxa: *D. prionotes* ○; *D. ferruginea* subsp. *magna* ★; *D. fraseri* var. *crebra* ●, *D. fraseri* var. *effusa* ✳; *D. ionthocarpa* subsp. *chrysophoenix* ☆ and *D. pteridifolia* subsp. *inretita* □.

In the key to species in George (1999) this runs to lead **69:** (p. 260). Couplet **71** should be amended thus:

71 Perianth 25–39 mm long
71a Leaves spreading, with 5–13 lobes each side; floral bracts glabrous; follicles 9–10 mm long ..... **D. armata**
71a: Leaves erect, with 10–18 lobes each side; floral bracts pubescent in upper half; follicles 13–16 mm long ..... **D. prionotes**
71: Perianth 22–24 mm long ..... **D. purdieana**

Dryandra pteridifolia R. Br., *Trans. Linn. Soc. London* 10: 215 (1810). *Type*: Bay I [Lucky Bay, Western Australia], Jan. 1802, *R. Brown* Iter Australiensis 3426 (*holo*: BM; *iso*: K).

Dryandra pteridifolia subsp. **inretita** A.S. George, *subsp. nov.*

Ab *Dryandra pteridifolia* R. Br. subsp. *pteridifolia* foliis parvis lobis filiformibus inflorescentiam cingentibus, differt.

Typus: S of Mallee Hill Rd on South Burngup Rd, Western Australia, 33° 19' S, 118° 58' E, 10 July 1998, *M. Pieroni* 98/4 (*holo*: PERTH 06406343; *iso*: AD, BRI, K, MEL, NSW).

Shrub with prostrate stems and lignotuber. *Leaves* similar to those of subsp. *pteridifolia*, but surrounding the inflorescence are many small leaves (less than 10 cm long) with filiform lobes. Flowers strongly scented like onions and honey. (Figure 1H)

Selected specimens examined. WESTERN AUSTRALIA: E of Lake Grace, *A.S. George* 16712, 30 July 1986 (PERTH); South Burngup Rd, S of Lake Grace–Newdegate Rd, *A.S. George* 16731, 1 Aug. 1986 (PERTH); Lake Grace–Newdegate Road, W of Buniche North Rd, *M.S. Graham*, 2 Feb. 1998 (PERTH); Reserve 24920, *R. Meissner* LB66, 1 Nov. 2000 (PERTH).

Distribution. Western Australia, between Lake Grace and Lake King.

Habitat. Sandy loam, sometimes over laterite, in open mallee kwongan.

Flowering period. July and August.

Conservation status. CALM Conservation Codes for Western Australian Flora: Priority Three.

Etymology. From the Latin *inretio* (to ensnare, entrap), in reference to the enmeshed aspect of the inflorescence being surrounded by short, finely lobes leaves.

Affinities. This differs from typical *Dryandra pteridifolia* in having many short leaves with filiform lobes surrounding the inflorescence. It occurs farther inland than subsp. *pteridifolia*. It is placed in this species rather than with *Dryandra fililoba* A.S. George, which has similar floral leaves but a pistil slightly shorter than the perianth.

The subspecies of *D. pteridifolia* may be keyed out as follows.

1. Inflorescence surrounded by many short leaves (less than 10 cm long) with filiform lobes ..... subsp. **inretita**
1. Inflorescence not surrounded by short leaves
   2. Leaf lobes usually twisted; pollen presenter 4.5–5 mm long; autumn-flowering ..... subsp. **pteridifolia**
   2. Leaf lobes not or little twisted; pollen presenter *c.* 8 mm long; spring-flowering ..... subsp. **vernalis**

Acknowledgments

Margaret Pieroni has continued to share her great knowledge of dryandras freely and to collect specimens of new taxa and variants, as well as named taxa from new localities. Fred and Jean Hort, Frank Obbens, Rob Davis, Leigh Sage and Brian Moyle have contributed useful collections from their field work, some of which require further study before they can be determined satisfactorily. The Western Australian Herbarium allowed access to its collections.

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Reinstatement of *Burchardia congesta* (Colchicaceae)

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Abstract

Keighery, G.J. and Muir, W.. Reinstatement of *Burchardia congesta* (Colchicaceae). *Nuytsia* 15(3): 347–353 (2005). *Burchardia* R. Br. is an endemic Australian genus of five species in the Colchicaceae. *Burchardia umbellata* R. Br. is a widespread taxon occurring disjunctly in temperate Eastern Australia and in south-west Western Australia. Studies on the morphology, ecology and anatomy of the Western and Eastern populations have shown marked discontinuities in character sets, leading to the recognition that each area is a seperate taxon. The name *B. congesta* Lindl. is re-instated for the Western populations and the name *B. umbellata* restricted to the Eastern populations.

Introduction

Burchardia R. Br. is an endemic Australian genus of Colchicaceae. Five species were recognised in a "Flora of Australia" treatment of the genus (Macfarlane 1987). As defined in that treatment, *Burchardia umbellata* R. Br. is a widespread taxon occurring disjunctly in temperate Eastern Australia (from south-east Queensland to Tasmania and South Australia) and in south-west Western Australia. However, Macfarlane noted that the western plants of this taxon differed from the eastern ones in habitat preference, in having yellow rather than purple anthers, and in having conspicuous glossy thickenings on the angles of the capsule.

Both Green (1964) and Beard (1969) commented on species which are disjunct between south-western and south-eastern Australia. Beard listed 280 taxa, while Green concentrated on the 34 species that had disjunctions of over 2,500 kilometres. In the Liliaceae *s. lat.* there were 16 such species listed by these authors. One additional species in this category, *Stypandra glauca*, has been noted by Henderson (1987d).

This publication presents the results of anatomical, cytological and morphological studies on populations of *Burchardia umbellata s. lat.* from eastern and western Australia and reports on the current status of other liliaceous taxa that have previously been listed as having similar disjunctions.

Materials and methods

Anatomical and cytological studies were undertaken on populations from Kings Park, Albany and Cockleshell Gully (Western Australia), the Mount Lofty Ranges (South Australia), Colac and Ballarat

(Victoria), Shellharbour (New South Wales) and Canberra (Australian Capital Territory). Voucher collections were lodged in UWA and the appropriate herbaria. For anatomical studies, whole plants were fixed in FAA. The material was then divided embedded in paraffin wax, sectioned on a rotary microtome at 10–12 µm and stained with safarin and fast green. Flower buds for cytological studies were fixed in Bradley's solution, stained in Snow's acid aceto-carmine and squashed in 45% acetic acid. Suitable spreads were photographed and made permanent using liquid nitrogen and mounting in Euparol. *Burchardia umbellata* collections in all major Australian herbaria were examined to compare the morphological characters of eastern and western plants.

Results

Anatomy of peduncles and pedicels

The peduncles and pedicels are structurally similar in populations from both areas, the major differences being a reduction in the amount of fibres in the eastern populations (Figure 1A). The vascular bundles are arranged in a double ring, below a layer of chlorenchymatous tissue and, in the western populations, are embedded in secondarily thickened parenchyma in both the peduncle and pedicel (Figures 1B and 1C). A pith of parenchyma is present in both areas. Structurally the vascular bundles are identical in form, consisting of a U-shaped xylem element surrounded by phloem (Figure 1D).

The difference in the peduncles and pedicels of the eastern and western populations probably relates to their ecology and life history. In Eastern Australia *Burchardia umbellata* is frequently a wetland plant. In Western Australia most *Burchardia* species favour winter-wet sites (*B. monantha* Domin and *B. rosea* Keighery) or swamps (*B. bairdiae* Keighery and *B. multiflora* Lindl.). Only *B. umbellata* is consistently a dryland species.

The western populations of *B. umbellata* retain their seeds in the capsule, which is held erect on top of the dry persistent inflorescence stalk. They are released slowly as wind shakes the capsules or as the old stalks fall over in autumn with the first rains. Observations on natural populations of *Burchardia umbellata* at Woodvale Nature Reserve (25 km north of Perth) have shown that seeds are mature by late November, the capsules open in late November after the seeds mature and the seeds fall to the base of the capsule. On December 30 all capsules still contain all the mature seeds, by January 30 22% of capsules have fallen or lost most of their seed, by Feb 28 all capsules have lost their seed, although all were still erect. A storm occurred before April 30 and most capsules were lying on the ground and less than 5% had seeds still retained. This retention of seed protects them from the very high surface temperatures of the sandy soils where they grow.

Retention of seed by the old inflorescences in south Western and Eremaean herbs is a very common but largely ignored trait in our flora. The other species have capsules that rapidly break down on maturity and release the seeds into the drying wetlands before the onset of summer. In *Burchardia rosea* which lacks strengthening tissue, like the eastern populations of *B. umbellata*, the peduncles collapse from wilting soon after picking. This also appears to be the case in *Burchardia umbellata* in Eastern Australia.

Leaf anatomy

Typical sections of the leaves cut 4 cm from the leaf apex are shown in Figure 1E. The greater width and thickness of the leaves of the western populations is immediately apparent, however, again they

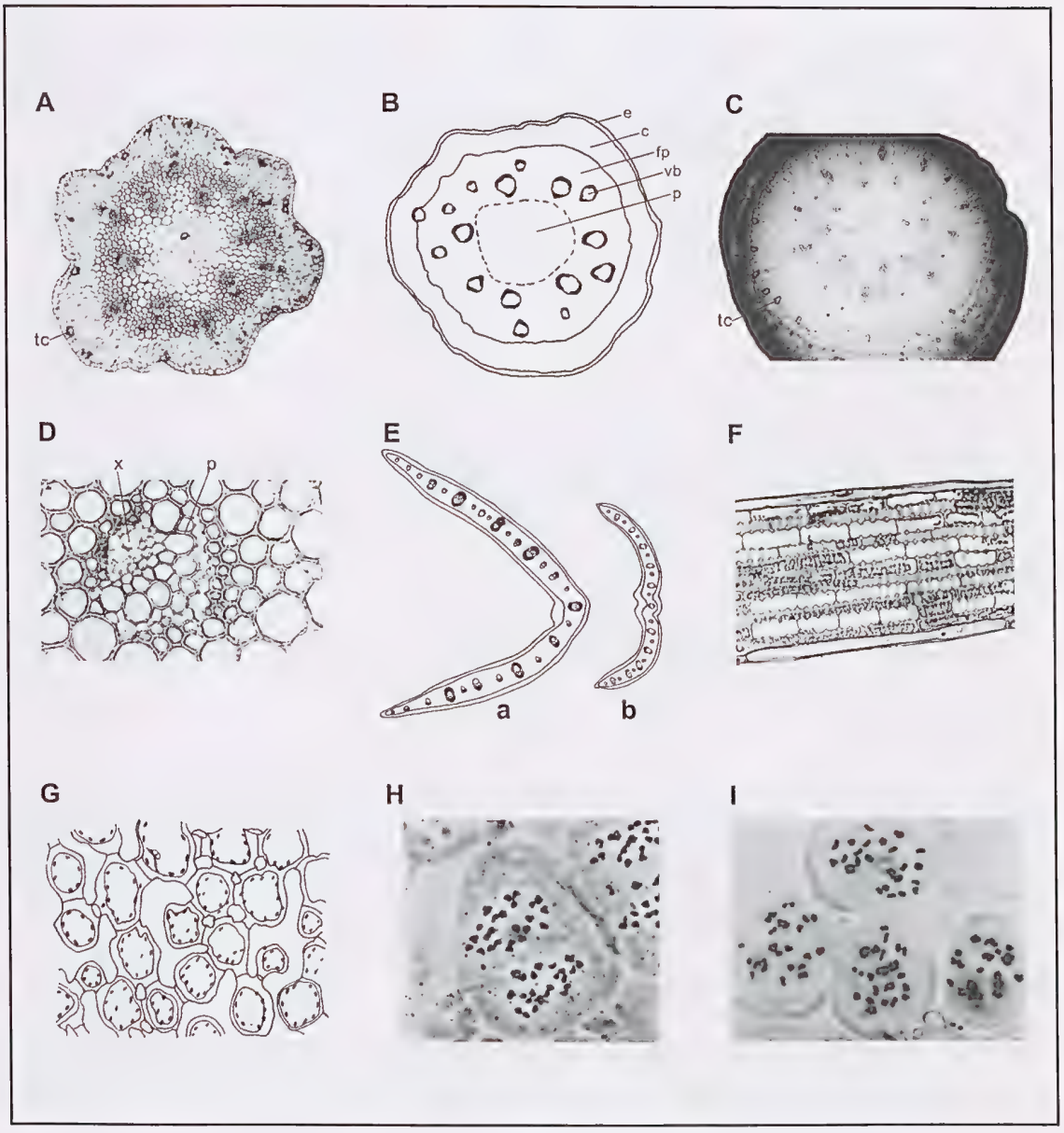

Figure 1. A – TS of pedicel of *Burchardia congesta,* from Cannington WA, ×30, tc=tannin cell; B – tissue diagram of TS of flowering stem of *Burchardia congesta*, from Kings Park WA, ×10, e=epidermal layer, c=chlorenchyma, fp=secondarily thickened parenchyma, vb=vascular bundle, p=parenchymatous pith; C – TS of base of flowering stem of *Burchardia umbellata*, from Colac Vic. – note lack of thickened parenchyma, ×30, tc=tannin cell; D – TS of vascular bundle of *Burchardia congesta*, from Kings Park WA, ×100, p=phloem, x=xylem; E – TS of leaves: a – *Burchardia congesta* from Kings Park WA, b – *Burchardia umbellata* from Ballarat Vic., ×2; F – LS of leaf of *Burchardia congesta*; G – TS of leaf of *Burchardia congesta*; H – meiotic chromosome spreads of *Burchardia umbellata*, ×1000; I – meiotic chromosome spreads of *Burchardia congesta*, ×1000.

are structurally similar. In both eastern and western samples, large and small veins alternate along the leaf and the structure of the vascular bundles is identical.

Burchardia leaves are very unusual in the Australian Lilies in that they lack any mesophyll or palisade parenchyma. Instead the chlorenchymatous tissue is composed of elongated parenchyma (Figure 1F) which are identical in cross-section (Figure 1G). These cells all possess chloroplasts and bear numerous cross connections to neighbouring cells (Figure 1G). This tissue would give the annually produced leaf its considerable rigidity despite its lack of fibres and great length.

Both forms have identical stomata, which are not shrunken, nor is the cuticle particularly thick since the plants only produce leaves during the growing season and are not subject to water stress.

Root morphology

Both forms have roots that are swollen storage organs from a short rhizome, that support the plant after the aerial parts die back at the onset of summer until re-growth occurs in the winter. Consequently the basal rhizome and large roots are packed with starch grains. There are none in the smaller annually-produced side roots. The development of the storage organs in the Western form is discussed in greater detail by Pate & Dixon (1982).

Cytology

All populations surveyed from eastern and western Australia were diploid with n = 24 (Figure 1H,I).

General morphology

This study confirmed Macfarlane's observations (1987) that the eastern material consistently differs from western collections in lacking thickened angles to the fruit and in possessing purple not yellow coloured anthers. Other differences noted were that the eastern Australian plants are smaller in stature, more slender than western plants and bear fewer flowers per umbel. Ovule number is consistently higher (7 per locule) in Western Australian plants versus 5 per locule in eastern plants.

Update on disjunct taxa reported for Liliaceae

As noted in the introduction, 17 species of Australian Liliaceae *s. lat.* have been recorded as having major disjunctions between south-western and south-eastern Australia. Table 1 lists these taxa and summarises the latest information on their status.

Of the 17 species listed, three have a distribution pattern that is not truly disjunct (*Bulbine semibarbata*, *Dianella revoluta* and *Tricoryne elatior*), one was a misidentification, five have been separated into western and eastern vicarious species, one as two subspecies (*Wurmbea dioica*) and two are cytologically separable as different biological species (*Chaemascilla corymbosa* and *Thysanotus patersonii*). This leaves only three species (*Burchardia umbellata*, *Dichopogon fimbriatus* and *Lomandra micrantha*) which are still considered to have disjunct occurrences in both sides of Australia with no significant differences. *Lomandra micrantha* itself is as currently understood a complex of three subspecies, two of which *Lomandra micrantha* subsp. *micrantha* and *L. micrantha* subsp. *teretifolia* are disjunct and the other *L. micrantha* subsp. *tuberculata* is confined to eastern Australia.

Table 1. Conspecific disjunct Liliaceae *s. lat.* listed by Green (1964), Beard (1969) and Henderson (1987d), and their current status.

Taxon	Current status
Borya nitida	Grampians plants segregated as a new species *B. mirabilis* (Churchill 1985).
Bulbine semibarbata	Not disjunct as grows in intermediate arid zone (Watson 1987).
Burchardia umbellata	Examined in this study.
Caesia parviflora	Material from Western Australia re-assigned to *C. micrantha* (Henderson 1987a).
Calectasia cyanea	Eastern Australian plants re-assigned to *C. intermedia* by George (1986) and Barrett & Dixon (2001).
Chaemascilla corymbosa	Eastern and western populations are cytologically very distinct, diploid vs. octoploid, probably not conspecific (Keighery 2001)
Corynotheca lateriflora	Misapplication of name. Eastern Australian plants now *C. licrota* and western *C. micrantha* (Henderson 1987b).
Dianella revoluta	Not disjunct as grows in intermediate arid zone. Taxonomy of this species complex not resolved (Henderson 1987c).
Dichopogon fimbriatus	Still regarded as disjunct (Brittan 1987b).
Dichopogon strictus	Misidentification, name applies to an eastern Australian species.
Laxmannia sessiliflora	Eastern Australian material segregated as a new species *L. orientalis* (Keighery 1987).
Lomandra glauca	*L. collina* is the current name. Not disjunct as grows in intermediate arid zone (Lee & Macfarlane 1986).
Lomandra micrantha	Three subspecies recognised, of which subsp. *micrantha* and subsp. *teretifolia*) are disjunct (Lee & Macfarlane 1986)
Stypandra glauca	This genus is currently under study and the eastern and western populations are proposed to be reinstated as separate species.
Thysanotus patersonii	Still disjunct (Brittan 1987a) but western plants are diploid and eastern ones octoploid (Brittan 1962) and they are anatomically distinct in stem structure (Brittan 1970).
Tricoryne elatior	Not disjunct as grows in intermediate arid zone. Taxonomy of this species complex not resolved.
Wurmbea dioica	Eastern (*W. dioica* subsp. *dioica*) and western (*W. dioica* subsp. *alba*) taxa separated as subspecies (Macfarlane 1980).

Taxonomy

The consistent morphological and ecological differences observed in the eastern and western populations of *Burchardia umbellata* indicate that two distinct taxa are involved. The differences are as great or greater than those separating the western and eastern taxa of other Australian Liliaceae at the species level shown in Table 1. As the type of *Burchardia umbellata* is from Port Jackson in eastern Australia, this name must be applied to the eastern species.

Two species names previously treated as synonyms of *B. umbellata* are based on Western Australian material. The earlier of these, *B. congesta*, is reinstated here and the later name *B. rigida* is listed below as a synonym. The other two synonyms listed for *B. umbellata* by Macfarlane (1987) are retained under that species.

Burchardia congesta Lindl., Sketch Veg. Swan R. lviii (1840). *Type:* Swan River, [Western Australia], 1839, *J. Drummond s.n.* (*holo:* CGE *n.v.*, photograph seen).

Burchardia [as *Burckhardia*] *rigida* Gand., *Bull. Soc. Bot. France* 66: 293 (1919). *Type:* Darlington, Darling Range, [Western Australia], *A. Morrison* (*n.v.*).

Updated key to *Burchardia* species

The only change required to the key to *Burchardia* given in "Flora of Australia" Volume 45 is the substitution of the name *B. congesta* for *B. umbellata* in the third couplet, as shown below. Distribution data have been added to the key as a further aid for identification of these taxa.

1. Flower solitary (Capel to Tunney) ..... **B. monantha**
1: Flowers 2 or more together, grouped in umbels
  2. Anthers purple
    3. Tepals white or with a faint pink abaxial mid-stripe; uppermost scape bract 7–40 mm long; longest umbel bract 4–12 mm long. (Eastern Australia) ..... **B. umbellata**
    3: Tepals pinkish white with a deep pink abaxial mid-stripe; uppermost scape bract 35–160 mm long; longest umbel bract 15–45 mm long. (Jurien Bay to Stirling Range) ..... **B. multiflora**
  2: Anthers yellow
    4. Flowers pink; tepal nectaries absent. (Kalbarri to Port Gregory) ..... **B. rosea**
    4: Flowers white or at most with a pink abaxial mid-stripe; tepal nectaries present
      5. Scape unbranched, rarely once branched; scape bracts 1 or 2; capsule thickened on angles. (Northampton to Stirling Range) ..... **B. congesta**
      5: Scape 1–4-branched; scape bracts 3 or 4; capsule not thickened on angles. (Cockleshell Gully to Jandakot) ..... **B. bairdiae**

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A taxonomic revision of *Drosera* section *Stolonifera* (Droseraceae), from south-west Western Australia

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Abstract

Lowrie, A. A taxonomic revision of *Drosera* section *Stolonifera* (Droseraceae), from south-west Western Australia. *Nuytsia* 15(3): 355–393 (2005). Ten species are recognized in the *Drosera* section *Stolonifera*: *D. fimbriata* DeBuhr, *D. humilis* Planchon, *D. platypoda* Turcz., *D. porrecta* Lehm., *D. purpurascens* Schlott., *D. ramellosa* Lehm., and *D. stolonifera* Endl., including three new combinations: *D. monticola* (Lowrie & Marchant) Lowrie, *D. prostrata* (Marchant & Lowrie) Lowrie and *D. rupicola* (Marchant) Lowrie. All are endemic to the south-west of Western Australia and belong in *Drosera* L. subgen. *Ergaleium* DC. sect. *Stolonifera* DeBuhr. Each taxon is described in detail as well as illustrated. A key is provided to all taxa in sect. *Stolonifera.* A schematic illustration of all ten species life-form is provided for comparison and cross referencing with each other. SEM micrographs of the seeds of each species, field and cultivation studies and historical investigations are also presented.

Introduction

The first three members of *Drosera* sect. *Stolonifera* to have been described were those that were most readily accessible to the early collectors in the Swan River Colony, as all were found in the vicinity of Perth. Endlicher (1837) described *Drosera stolonifera*, based on an early collection from the Swan River and this was followed by Lehmann's (1844) descriptions of *Drosera ramellosa* from Rottnest Island and *D. porrecta* from Mount Eliza in the present day Kings Park overlooking the City of Perth where this species can still be found.

Planchon (1848) assigned these three species to sect. *Ergaleium* Planchon and his series *Erythrorhizae* subseries *Stoloniferae* [as *Stolmiferae*] and added the new species *D. humilis*. He also named *D. penduliflora* but this was later reduced (Bentham 1864) to synonymy under *D. ramellosa*. Two further species, *Drosera platypoda* and *D. purpurascens*, were added by Turzaninow (1854) and Schlotthauber (1856).

Bentham (1864) in his "Flora Australiensis" recognised fewer taxa and also suggested that *D. humilis* might prove to be a variety of *D. stolonifera*. He did not agree with Planchon's infrageneric classification, adopting a much simpler division of the entire genus into two sections, placing all tuberous species in sect. *Ergaleium* Planchon and non-tuberous ones in sect. *Rorella* DC.

Diels (1906) reduced *D. humilis* to a variety of *D. stolonifera* as suggested by Bentham but preferred a more complex classification of the genus *Drosera*. He included *D. stolonifera* and its relatives in sect.

Erythrorhiza (Planchon) Diels of subg. *Ergaleium* DC. Another section of this subgenus recognised by Diels was his new sect. *Polypeltes* Diels, which was characterised by the leaves being cauline and peltate.

No further members of the species group were described until DeBuhr (1975) named *Drosera fimbriata*, a species resembling *D. stolonifera* in its whorled leaves as well as sepal and inflorescence characters but differing in its leaves being peltate. It was questionable whether *D. fimbriata* should be positioned in Diel's sect. *Polypeltes* because it had cauline, peltate leaves or in sect. *Erythrorhiza* because it had whorled leaves.

This problem prompted Debuhr's (1977) re-evaluation of the sectional classification of *Drosera* subgen. *Ergaleium* based on anatomical studies of 28 tuberous species. He established that subgen. *Ergaleium* could be divided into three natural groups of species with the introduction of a third section, sect. *Stolonifera* based on Planchon's subser. *Stoloniferae*. Into his new section he placed *D. fimbriata, D. platypoda, D. ramellosa* and *D. stolonifera.* He retained sect. *Polypeltes* now known by the earlier name sect. *Ergaleium* for those species having an erect or climbing habit and alternate, peltate, cauline leaves; and sect. *Erythrorhiza* for the rosetted species.

In their treatment of *Drosera* sect. *Stolonifera* for "Flora of Australia", Marchant & George (1982) recognized four species, *Drosera fimbriata, D. platypoda, D. ramellosa* and *D. stolonifera*, the last of which was divided into four subspecies. Three additional subspecies of *Drosera stolonifera* were recognised in later publications (Marchant & Lowrie 1987, Lowrie & Marchant 1992), including two newly discovered taxa. This brought the total number of taxa recognised in the section to ten.

Materials and methods

Extensive field studies of the ten taxa in sect. *Stolonifera* were undertaken in the south-west of Western Australia from 1980 to 2001. Specimens were examined in the field at the time of their first emergence from their summer dormancy right through to the stage when the seeds were ripe.

Specimens of all ten species were brought from the field into cultivation where they were grown in similar soils of 50/50 peat and silica sand soils in 15 cm diam plastic flower pots. Plants were watered from below via a 5 mm depth of water where the pots were stood in trays, 30% shade cloth was used to cut down sunlight and shade cloth windbreaks were provided to protect the plants from dry easterly winds.

When the specimens had finished their above ground growth cycles, water was reduced slowly over a two month period to provide a little soil moisture while the stolon slowly receded from the soil surface. As the stolon (being that portion between the plant at the soil surface and the old tuber below) in mature plants recedes it gradually transfers all of its bulk and energy into a new tuber which is either developed along side of the old spent tuber or renewed within the skin of an existing but emaciated tuber. The skin of the tubers that follow this later arrangement eventually turn into a paper-like consistency which tightly shrouds the tuber. A new and persistent papery sheath is added around the tuber annually as a result of this tuber renewal process. As one papery sheath is added annually, an approximate age of a mature plant (excluding its juvenile stages leading up to maturity) can be established by peeling and counting each papery sheath shrouding its tuber, one papery sheath representing one year of life.

Specimens were grown side by side under similar growing conditions. All ten taxa in cultivation produced healthy robust plants because of the constant moisture availability, protection from pests and the effects of the sometimes devastating elements of the weather such as irregular seasonal rains in drought affected seasons, prolonged frosts or pounding rain combined with hail. These cultivation studies showed, even though they were healthy non stressed plants, they still maintained their respective life-forms and growth cycles to that which normally occurred in the field.

Seed micromorphology was studied using scanning electron microscopy (SEM). Seeds were cleaned of dust with a fine brush, mounted on stubs with double-sided adhesive tape, coated with gold-carbon in a vacuum evaporator and examined under a Phillips XL-20 SEM at 10 kV. The SEM work was carried out under the direction of my colleague Dr John Conran of the Department of Environmental Biology at The University of Adelaide. All seeds for the SEM work were harvested by the author from specimens that best matched the type material for each of the ten taxa.

Type material was examined for all ten taxa. The illustrations were drawn by the author from live material. Morphological descriptions were based on these fresh dissections as well as dried and spirit materials.

Results

Life form

Controlled cultivation experiments established that there was no noticeable difference for each species in its overall life-form to that found in the field. This showed each species life-form was genetic and not influenced by different habitat or moisture availability conditions. Schematic life-form illustrations for the ten taxa are presented for direct comparison (Figure 14).

Drosera monticola, D. porrecta and *D. purpurascens* display quite different life-forms between their flowering and non-flowering modes, so both are illustrated to show these differences. One taxon, *D. porrecta* has its basal rosette(s) borne above the soil surface whether flowering or not, whereas all other taxa have basal rosettes situated on the soil surface. A lack of knowledge of this all-important character has led to erroneous interpretations by some previous authors. For example, both Diels (1906) and Planchon (1848) believed *D. stolonifera* and *D. porrecta* to be conspecific simply because of the way the leafy growth branched above the basal rosettes in both taxa. Without the benefit of field observations, they could not have known that the basal rosette of *D. porrecta* bearing its branching state is always situated above the soil surface, nor that this branching arrangement is only found in flowering specimens. *D. porrecta* often has more than one basal rosette, whereas *D. stolonifera* always has a solitary basal rosette situated on the soil surface whether it is flowering or not.

Drosera humilis, D. purpurascens and *D. stolonifera* have a horizontal stolon (in addition to a vertical stolon which is situated between the tuber and where it first emerges from the soil) which rests on the soil surface. Often this stolon is lightly covered with a thin layer of wind-blown sand and/or leaf litter humus. In *D. humilis* these horizontal stolons are commonly on average 6 cm long.

Seed morphology

The SEM micrographs of seeds for all taxa in *Drosera* sect. *stolonifera* are presented in Figures 11, 12 and 13. These SEM micrographs clearly illustrate that each of the 10 taxa in section *Stolonifera* differ from each other in seed size, with measurements ranging between 0.3–1.5 mm long, 0.2–1.5 mm wide or diam.; seed shape, being broadly obovoid, cupiform, ellipsoid, globose, subglobose, spherical, turbinate or variably shaped with rounded and angled sides; apical pole, indented or truncate with or without a central umbo surrounded by a flattened apron; basal pole funicle barely projected or prominently projected beyond the overall seed shape; surface sculpturing, testa cell patterns ranging from reticulate, foveate, hexagonal, tetragonal, ruminate and scaly; and cell ridges shallow and smooth, shallow and irregular, irregular undulate or irregular and longitudinally dentate.

Conclusions

These studies have shown that each of the ten taxa in sect. *Stolonifera* are very different from each other. Seed characters alone are sufficient to distinguish all of the taxa. The combination of life-form (see fig. 14: A–M, schematic life-form illustration) and other morphological characters such as: tuber colour; basal rosettes present or not; variable leaf shapes; leafy stems either simple or branched; cauline leaves solitary or in whorled groups; inflorescences basal, terminal or arising from the axils of the upper leaves, also gives a complete separation between all taxa. Life-form is constant in the field over the total range for each species and is maintained even under cultivation in foreign soils in an artificially controlled environment.

Three species pairs, *Drosera humilis and D. prostrata, D. porrecta* and *D. stolonifera,* as well as *D. porrecta* and *D. purpurascens* were found to coexist with each other in the field. No hybrids or intermediates between these species were found suggesting that there are effective breeding barriers between them.

The combined results from all these lines of enquiry provide strong evidence for each of the ten taxa in sect. *Stolonifera* to be treated as legitimate species.

Taxonomy

Drosera section **Stolonifera** DeBuhr, *Austral. J. Bot.* 15: 215 (1977). – *Drosera* subser. *Stoloniferae* Planchon [as *Stolmiferae*], *Ann. Sci. Nat.* (Paris) ser. 3,9: 95 (1848). *Type: Drosera stolonifera* Endl.

Perennial *herbs*, with a red or orange tuber covered in brown papery sheaths which are sometimes additionally densely covered with persistent root fibres, with a rosette of leaves (sometimes lacking in *D. prostrata*) on or a short distance above the soil surface and 1 or more leafy stems arising from the basal rosette. *Leaves* reniform, spathulate, obovate with the leaf lamina along with its petiole longitudinally semi-folded to appear pseudo-peltate, or if peltate (i.e. *Drosera fimbriata*) at first in whorls then solitary and alternate towards the apex, with insectivorous glands (also some non-insectivorous leaves present in *Drosera fimbriata*). *Leafy stems* simple or branched, erect when solitary, spreading semi-erect or prostrate when two or more; upper cauline leaves borne singly or whorled in groups of 3 to 4. *Inflorescences* terminal and sometimes also from the axils of the upper cauline leaves well below

the apex. *Seeds* very variable, spherical, subglobose, obovoid, ellipsoid, turbinate, cupiform or with rounded and angled sides within a cylindrical or rectangular figure.

Key to *Drosera* section *Stolonifera*

1. Plants with non-insectivorous whorled fimbriate leaves on the basal portions of the stem; upper cauline leaves peltate (Scott River to Manypeaks area) ..... **D. fimbriata**
1. Plants with all leaves insectivorous; upper cauline leaves not peltate 2
2. All leaves solitary, alternate along the erect stems 3
2. Leaves commonly whorled along the erect and/or lateral stems 4
3. Inflorescence arising from the centre of the basal leafy rosette, infructescence pendulous (Kalbarri to Cranbrook to Mt Ragged area) ..... **D. ramellosa**
3. Inflorescence terminal, infructescence erect (Manjimup to Scott River to Albany area) ..... **D. platypoda**
4. Leafy stems appressed to the soil surface... (Tamala area to Binnu) ..... **D. prostrata**
4. Leafy stems semi-erect and/or erect, held above soil surface 5
5. Cauline leaf lamina transversely elliptic to depressed ovate, slightly longitudinally folded; lamina sides mobile, folding together onto captured insects during the digestion process (Pithara to Hyden area) ..... **D. rupicola**
5. Cauline leaf lamina flabellate, circular or reniform; lamina sides non-mobile, remaining apart 6
6. Cauline leaf lamina flabellate. Flowers pink. Plants asexually forming colonies, restricted to the cloud lines of mountain summits (Stirling Range) ..... **D. monticola**
6. Cauline leaf lamina circular and/or reniform with a distinctive upper wedge-shaped gap, or fully reniform. Flowers white. Solitary plants of the lowlands and hills 7
7. Cauline leaf lamina reniform and/or circular with a distinctive upper wedge-shaped gap 8
7. Cauline leaf lamina fully reniform 9
8. Plant without a prostrate stolon, foliage robust; lowermost basal rosette of leaves above the soil surface. Cauline leaf petiole longitudinally channeled on upper edge. Leafy stems arising from the uppermost of 1–3 basal rosettes, laterally branching only when flowering. (Eneabba and Marchagee to Pinjarra) ..... **D. porrecta**
8. Plant with prostrate stolon above the soil surface, foliage fine; lowermost basal rosette of leaves appressed to the soil surface. Cauline leaf petiole terete. Leafy stems arising from the basal rosette, laterally branching whether flowering or not. (Kalbarri to Moore River to Wongan Hills) ..... **D. humilis**
9. Plants 3–10 cm tall, cauline leaf petioles 8–30 mm long, non-flowering specimens often with only 1 erect leafy stem, bearing additional solitary cauline leaves with long petioles at the base. (Katanning to Ongerup to Albany area) ..... **D. purpurascens**
9. Plants 15–25 cm tall, cauline leaf petioles 5–10 mm long, non-flowering specimens with 3 or more semi-erect leafy stems, without additional solitary cauline leaves at the base (Perth to Pinjarra) ..... **D. stolonifera**

Drosera fimbriata DeBuhr, *Aliso* 8: 267 (1975). *Type:* 18 miles [28.8 km] north-east of Manypeaks along road to Jerramungup, Western Australia, 14 October 1974, *DeBuhr* 4098 (*holo:* RSA; *iso:* CANB, K, PERTH 1053191, US).

Illustration. J. Deliana, *Aliso* 8: 265, fig. 1, D–G, (1975).

Photographs. L. Debuhr, *Aliso* 8: 270, fig. 4, A& C, (1975); S. Carlquist, *Aliso* 8: 268, fig. 3, A–D, 270, fig. 4, B& D, (1975); A. Lowrie, *Carnivorous Plants of Australia* vol. 1, 115 A–D (1987).

A tuberous-rooted *perennial herb;* leafy stem solitary, erect, glabrous, 10–15 cm tall, lower portion of stem with 2 or 3 whorls of non-insectivorous leaves, followed by 2–5 whorls of insectivorous leaves and a few alternate solitary leaves near the apex. *Tuber* orange, ellipsoid, *c.* 10 mm long, *c.* 7 mm diam., enclosed in brown papery sheaths and again enclosed in a mass of old coarse root fibre; vertical stolon (below ground) *c.* 10 cm long. *Non-insectivorous leaves* linear, 4–6 mm long, 0.4–0.7 mm wide, margins fimbriate, fringes up to 3 mm long; *Insectivorous leaves* in 3–5-leaved whorls at base, then sometimes opposite but always solitary and alternate near apex; petiole terete, 5–18 mm long, peltate, glabrous; lamina suborbicular in outline but truncate-emarginate a little at the top and therefore forming an overall broadly reniform shape, 2.5–4 mm diam., adaxial surface with insect-trapping glands around the margins and smaller glands within, abaxial surface glabrous. *Inflorescence* either a simple raceme or a corymb, terminal, 4–18-flowered, 3.5–6.5 cm long (including scape), glabrous; pedicels 3–5 mm long, glabrous. *Sepals* green, ovate, acute, 3.5–5.5 mm long, 2–2.5 mm wide, margins often irregularly dentate in upper half, black dotted, glabrous. *Petals* white, cuneate, apex crenate, 8–10 mm long, 5–8 mm wide. *Stamens* 5, 1.5–2.5 mm long; filaments white; anthers white with reddish dots, pollen pale yellow. *Ovary* green, subglobose, *c.* 0.8 mm long, *c.* 1 mm diam. at anthesis; carpels 3, bilobed. *Styles* 3, white, reddish at base, *c.* 1 mm long, each divided into many segments, some arranged in a whorl, fused at the base and curved upwards to the apex, a small number erect in the centre, each free style segment terete and tapering towards apex; stigmas forming a slender projection at the apex of each style segment. Fruit ellipsoid, 2–3 mm long, 2.5–3 mm diam., containing *c.* 20 seeds. *Seeds* black, spherical to subglobose, testa cell pattern irregularly honeycombed, reticulate, cell shape longitudinally hexagonal, ridges and cell floors irregularly undulate, 0.4–0.5 mm diam. (Figures 1: (species illustration); 11: A–B (seed micrographs); 14: A (schematic life-form illustration))

Other specimens examined. WESTERN AUSTRALIA: William Bay National Park, SW of Denmark, 27 Sep. 1990, *B.G. Hammersley* 383 (PERTH); on Hassell Highway, 29 km NE of Manypeaks, 19 Oct. 1992, *A. Lowrie* 692 (MEL, PERTH); Scott River Rd, E of Augusta, 7 Dec. 1993, *A. Lowrie s.n.* (PERTH); 9.9 km NE of Manypeaks on Highway 1, 7 Oct. 1996, *A. Lowrie* 1580 (MEL, PERTH); 25.1 km NE of Manypeaks on Highway 1, 7 Oct. 1996 *A. Lowrie* 1583 (MEL, PERTH); 2 km NE of Manypeaks on Highway 1, 10 Oct. 2000 *A. Lowrie* 2577B (MEL, PERTH); 27 km NE of Manypeaks on Highway 1, 10 Oct. 2000 *A. Lowrie* 2578B (MEL, PERTH); 15 km W of Ledge Point, 2 Oct. 1974, *K.R. Newbey* 4452 (PERTH).

Distribution. Known from a few collections from the Scott River area east to the Denmark area, but mostly collected in the Manypeaks area.

Habitat. Drosera fimbriata grows in winter-wet, well drained, white or grey sandy soils, amongst low shrubs on heathland east of Manypeaks and Scott River regions. In the Denmark area it grows in moss pads with *Borya* species.

Flowering period. October.

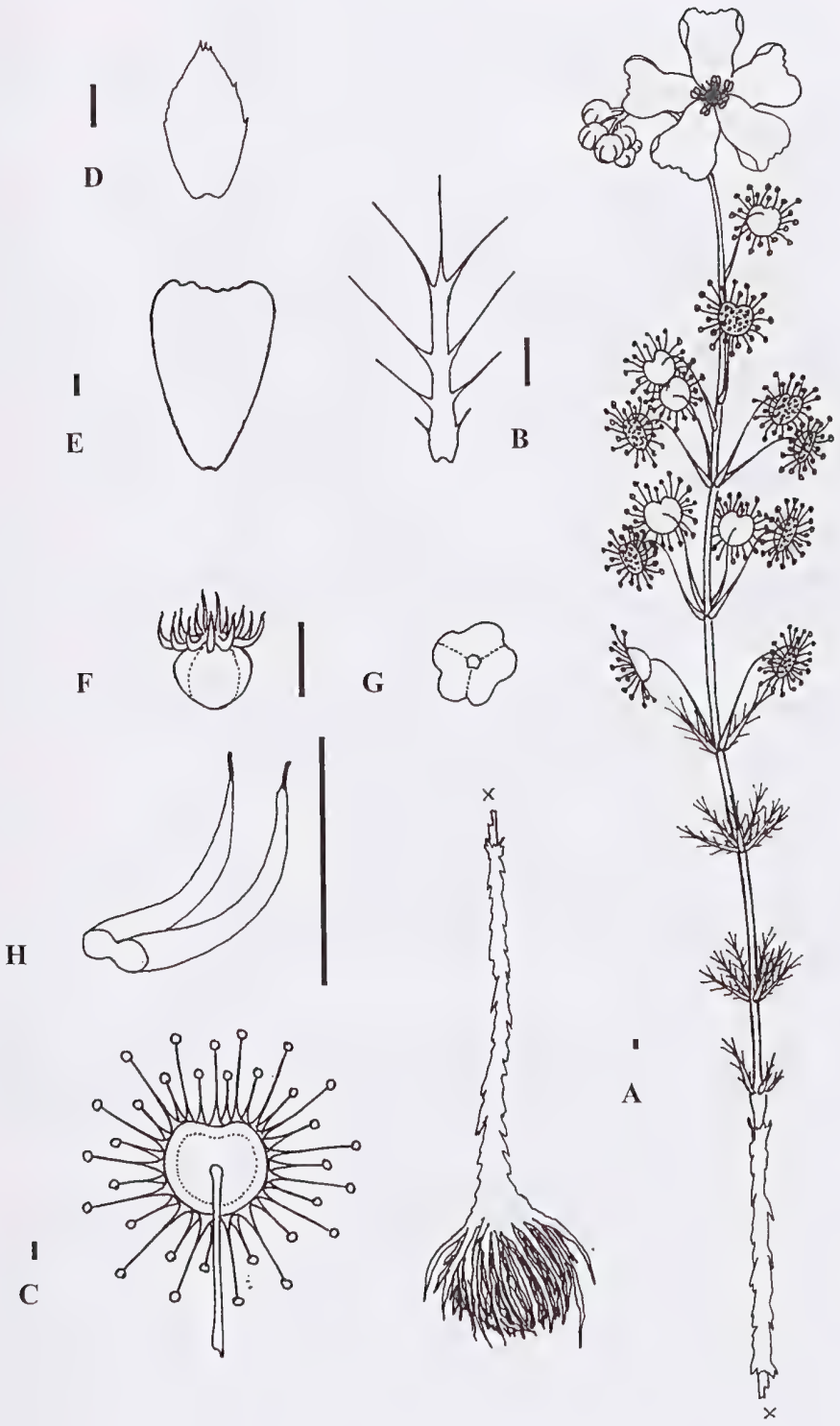

Figure 1. *Drosera fimbriata.* A.–plant; B.–basal non-insectivous fimbriate leaves; C.–cauline leaf lamina; D.–sepal; E.–petal; F.–ovary-styles; G.–ovary, basal view; H.–style-stigmas, enlarged. Scale bars for all = 1 mm. Drawn by A. Lowrie in 1984 from live material from north east of Manypeaks, Western Australia, voucher *A. Lowrie* 692.

Conservation status. Conservation Codes for Western Australian Flora: Priority Four. Although it has not been thoroughly and systematically surveyed in the Manypeaks region, the species is abundant there and currently not under threat. It is also currently secure in the William Bay National Park south-west of Denmark.

Unfortunately the *Drosera fimbriata* populations in the Scott River region are not safe. The few known locations for the species in this region are situated near an active mining lease. The species could be threatened with extinction there if sand mining, dredging, temporary or permanent storage of overburden spoil or roads to service the sand mining operation were expanded or developed before a management plan for the species was in place. One population of *D. fimbriata (A. Lowrie s.n.,* 7 Dec. 1993) has already been destroyed by the construction of a sealed service road to the current sand mine dredging operations in the area.

Etymology. From the Latin *fimbriatus* – fringed, in reference to the fimbriate nature of the modified leaves on the lower portion of the stem.

Affinities. Drosera fimbriata is unusual in that its cauline leaves are fully peltate, a condition not met with in other members of section *Stolonifera.* The non-carnivorous fimbriate basal leaves are not only unique to section *Stolonifera* but also to all other tuberous sundews. Even though *D. fimbriata* is somewhat atypical of section *Stolonifera* is it is best placed for now in this section.

Its tubers are covered in brown papery sheaths, which in turn are densely covered with spent root fibre similar to that found in *D. platypoda.* The inflorescence arrangement and flowers are more or less similar to that found in *D. platypoda, D. porrecta* and *D. stolonifera.*

Notes. The whorled linear fimbriate leaves are at first erect, shrouding and providing a spikey protective barrier for the juvenile major axis growth bud as it emerges from the soil and for a short period thereafter. These leaves are later arranged semi-erect so that all of the fringes of the leaves slightly overlap each other, resembling a web around the basal stem. This leaf arrangement appears to be simply a barrier against crawling insects that might feed on the upper leaves or the inflorescence.

Drosera humilis Planchon, *Ann. Sci. Nat.* (Paris) ser. 3, 9: 300 (1848). – *Drosera stolonifera* var. *humilis* (Planchon) Diels, *Pflanzenr.* 26: 126 (1906). – *Drosera stolonifera* subsp. *humilis* (Planchon) N. Marchant, *Fl. Australia* 8: 384 (1982). *Type:* "cum praecedente; Drummond in herb. Hook. [south-west Western Australia, *J. Drummond s.n.*]" (*iso:* K).

Illustration. R. Erickson, *Plants of Prey in Australia,* plate 4: upper right (1968).

Photographs. A. Lowrie, *Carnivorous Plants of Australia* vol. 1, 135 A–C (1987).

A tuberous-rooted *perennial herb*, with 3–5 semi-erect lateral stems 3–15 cm long arising from the centre of a small basal rosette of leaves; foliage fine, reddish or golden green, leaves of the lateral stems in whorls of 3 or 5. *Tuber* orange, globose, *c.* 10 mm diam., enclosed in a number of brown papery sheaths; stolon vertical (below ground), *c.* 20 cm long, stolon prostrate (on soil surface) 4–8 cm long. *Basal leaves* petiole flat, 2.5–3.5 mm long, 0.5–0.7 mm wide; lamina obovate and flabellate, 1.5–2 mm long, 2–3 mm wide, adaxial surface with insect trapping retentive glands around the margins and smaller glands within. *Cauline leaves* petiole terete, tapering, 5–15 mm long; lamina circular to reniform always with an upper wedge-shaped gap, 1.5–2 mm long, 2–3 mm wide, with insect-trapping retentive glands around the

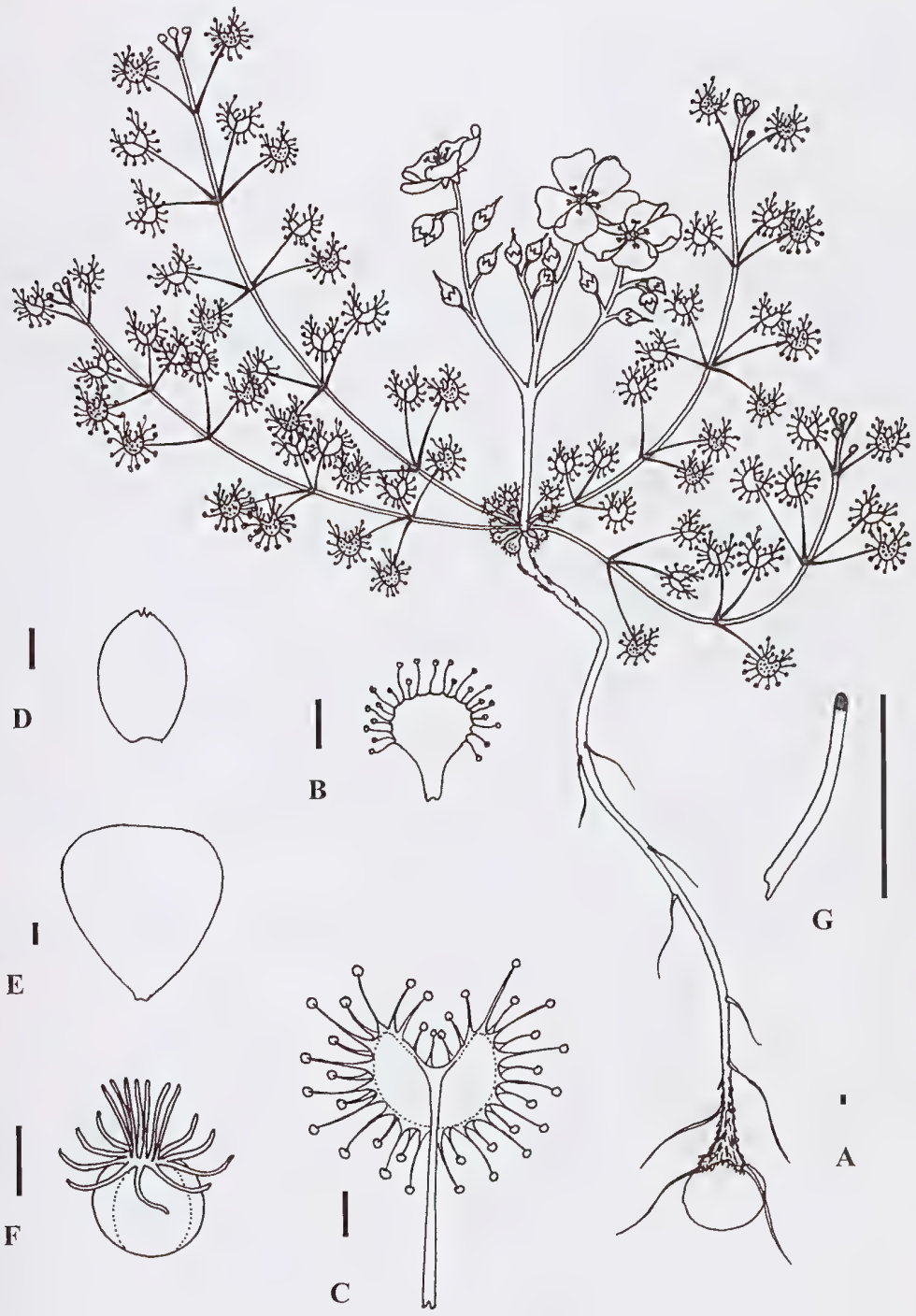

Figure 2. *Drosera humilis*. A.–plant; B.–basal leaf lamina; C.–cauline leaf lamina; D.–sepal; E.–petal; F.–ovary-styles; G.–style-stigma, enlarged. Scale bars for all = 1 mm. Drawn by A. Lowrie in 1984 from live material from Kalbarri, Western Australia, voucher *A. Lowrie s.n.*, 6 July 1991.

margins and smaller glands within. *Inflorescence* of a number of simple racemes or 2–4-branched corymbs, the major one arising from the basal rosette of leaves and smaller ones sometimes arising terminally from the semi-erect lateral leafy stems; racemes or corymbs 2–10 cm long (including scape), 5–45-flowered, scape and pedicels yellowish green with scattered minute glands; pedicels 3–7 mm long. *Sepals* green, ovate or elliptic, acute, 2.5–4.5 mm long, 1.7–3 mm wide, margins entire, apex sometimes slightly dentate, adaxial surface with a few scattered minute sessile glands, otherwise glabrous. *Petals* white, obovate, apex truncate, 5–7.5 mm long, 4–5 mm wide. *Stamens* 5, 2.5–3 mm long; filaments white; anthers and pollen yellow. *Ovary* green, subglobose, *c.* 1 mm long, *c.* 1.5 mm diam., at anthesis. *Styles* 3, white, *c.* 1 mm long, each divided into many terete segments, some arranged in a whorl and curved out and upwards from their base, a number erect in the centre of the whorl; stigmas simply formed at the apex of each style segment. *Fruit* obovoid, *c.* 5 mm long, *c.* 4.5 mm diam., containing *c.* 16 seeds. *Seeds* brown, variably shaped with ± rounded and angled sides, testa cell pattern scaly, scales ± scallop seashell-like, imbricate, 1–1.5 mm long, 0.8–1.5 mm diam. (Figures 2: (species illustration); 11: C–D (seed micrographs); 14: B (schematic life-form illustration))

Other specimens examined. WESTERN AUSTRALIA: Drummond's Cove near Geraldton, 16 Aug. 1969, *A.C. Burns* 57 (PERTH); 13 miles [20.8 km] W of Mogumber, 31 Aug. 1966, *A.S. George* 7795 (PERTH); 161.25 miles [258 km] from Mount Magnet on Geraldton road, 17 Aug. 1963, *D.W. Goodall* 2004 (PERTH); 7 km S of Eneabba, 2 Aug. 1977, *E.A. Griffin* 937 (PERTH); on road to The Loop, Kalbarri, 6 July 1991, *A. Lowrie s.n.* (MEL, PERTH); E of Ross Graham turn off, Kalbarri, 4 Sep. 1992, *A. Lowrie* 644 (MEL, PERTH); 3.2 km N of Wongan Hills, 13 Sep. 1996, *A Lowrie* 1543 (MEL, PERTH); near Westrail Station, Arrowsmith, 20 Aug. 1997, *A. Lowrie* 1800 (MEL, PERTH); 13.3 km W of Binnu, 21 Aug. 1997, *A. Lowrie* 1810 (MEL, PERTH); 16.7 km W of Binnu, 21 Aug. 1997, *A. Lowrie* 1814 (MEL, PERTH); 17.3 km W of Binnu, 21 Aug. 1997, *A. Lowrie* 1816 (MEL, PERTH); 49 mile peg [78.4 km] on Geraldton–Mullewa road near Tenindewa, 28 Aug. 1964, *N. Marchant* 64183 (PERTH); Howatharra Hill Reserve, Moresby Range, 21 road miles [33.6 km] N of Geraldton, 8 Aug. 1974, *D. & N. McFarland* 1067 (PERTH).

Distribution. Drosera humilis is common species from the Moore River north to Kalbarri and inland to Ajana in the north and Wongan Hills in the south.

Habitat. Drosera humilis grows in well drained winter wet deep white or yellow sandy soils amongst low shrubs on heathland on the northern sand plains.

Flowering period. June to September.

Conservation status. Drosera humilis is a common species and is currently not under threat.

Etymology. The epithet, from the Latin *humilis* meaning low growing, refers to its small low growth habit.

Affinities. Drosera humilis differs from all species in the *D. stolonifera* complex by flowering well before the plant is fully developed, and by its fine foliage; cauline leaves with terete petioles and circular to reniform lamina always with an upper wedge-shaped gap; and large, brown, rounded and angled seeds.

Notes. Drosera humilis (A. Lowrie 1816) coexists with *D. prostrata (A. Lowrie* 1815) in the Binnu region without apparently hybridizing. *D. humilis* has also been recorded (without vouchers) growing side by side with *D. prostrata* (*G.J. Keighery & N. Gibson* 1453 and 1535), near Zuytdorp National Park, in two permanent 20 m x 20 m quadrants without apparently hybridizing. These discoveries provide further evidence that these two taxa are genetically isolated from each other and both taxa should be treated as distinct entities (Neil Gibson pers. comm.).

Drosera monticola (Lowrie & Marchant) Lowrie, *comb. nov.*

Drosera stolonifera subsp. *monticola* Lowrie & Marchant, *Nuytsia* 8(3): 323–332 (1992). *Type:* summit of Toolbrunup Peak, Stirling Range National Park, Western Australia, 14 November 1989, *P. Mann s.n.* (*holo:* PERTH 02642964).

Photographs. A. Lowrie, *Carnivorous Plants of Australia* vol. 3, 251 A–F (1998).

A tuberous-rooted *perennial herb*; main stem usually not developed in non-flowering specimens, more or less erect, 2–7 cm tall; foliage reddish, basal leaves in a rosette, cauline leaves usually scattered, rarely sub-opposite or whorled. *Tuber* bright red, globose, *c.* 6 mm diam., enclosed in a number of black papery sheaths; stolon vertical (below ground), *c.* 3.5 cm long, branching laterally (below ground) and asexually producing additional tubers and producing compact plant colonies. *Basal leaves* petiole flat, tapering, 3–5 mm long, 0.5–1.5 to 1–2 mm wide; lamina broadly obovate, 3–6 mm long, 3–6.5 mm wide, adaxial surface with insect trapping retentive glands around the margins and smaller glands within. *Cauline leaves* petiole dilated towards the lamina, 10–30 mm long, 0.4–0.9 to 0.7–1 mm wide, longitudinally channeled above; lamina flabellate, distinctly concaved, 3–5 mm long, 4–8 mm wide, with insect trapping retentive glands around the margins and smaller glands within. *Inflorescence* a simple raceme, terminal, 3–5 cm long (including scape), glabrous; pedicels 5–11 mm long, 1–5-flowered. *Sepals* greenish orange, ovate, acute, 4–5 mm long, 2–2.5 mm wide, lower margin entire, upper margin and apex irregularly dentate-crenate, glabrous. *Petals* pale pink with dark pink closely spaced flabellate veining, obovate, 8–9 mm long, 4–5 mm wide. *Stamens* 5, 2.5–3 mm long; filaments white tinged brown; anthers white, pollen yellow. *Ovary* green, ellipsoid, *c.* 1.3 mm long, *c.* 1.2 mm diam. at anthesis. *Styles* 3, white, *c.* 0.8 mm long, each divided into many terete segments, half of them forming an irregular horizontally spreading whorl, remainder erect; stigmas simply formed at the apex of each style segment. *Fruit* when mature unknown. *Seeds* (mature seed unknown, current data from immature seed only, see notes below) mature seed colour unknown, ± subglobose, testa cell pattern ruminate, *c.* 0.3 mm long, *c.* 0.2 mm diam. (Figures 3: (species illustration); 11: E–F (seed micrographs); 14: C & D (schematic life-form illustrations))

Other specimens examined. WESTERN AUSTRALIA: summit of Bluff Knoll, Stirling Range, 8 Nov. 1994, *S. Barrett s.n.* (PERTH); summit of Toolbrunup Peak, Stirling Range, 26 Nov. 1991, *A. Lowrie* 530 (MEL, PERTH); summit of Bluff Knoll, Stirling Range, 8 Oct. 1991, *P. Mann s.n.* (MEL, PERTH).

Distribution. Drosera monticola is common species on the summits of Toolbrunup Peak and Bluff Knoll. It is likely to occur on the summits of other peaks of the Stirling Range.

Habitat. Drosera monticola is restricted to winter moist, black or brown loamy soils on ledges and in shallow depressions, often growing with moss. Only recorded from the upper slopes and summits which are frequently cloud-covered and are usually very moist. Its habitat on Bluff Knoll is often covered with snow for short periods in winter.

Flowering period. October to November.

Conservation status. Drosera monticola is a relatively common species in the Stirling Range National Park where it is not under threat.

Etymology. From the Latin *montis* – mountain and *cola* – dweller, in reference to this species being restricted to the summits of the Stirling Range.

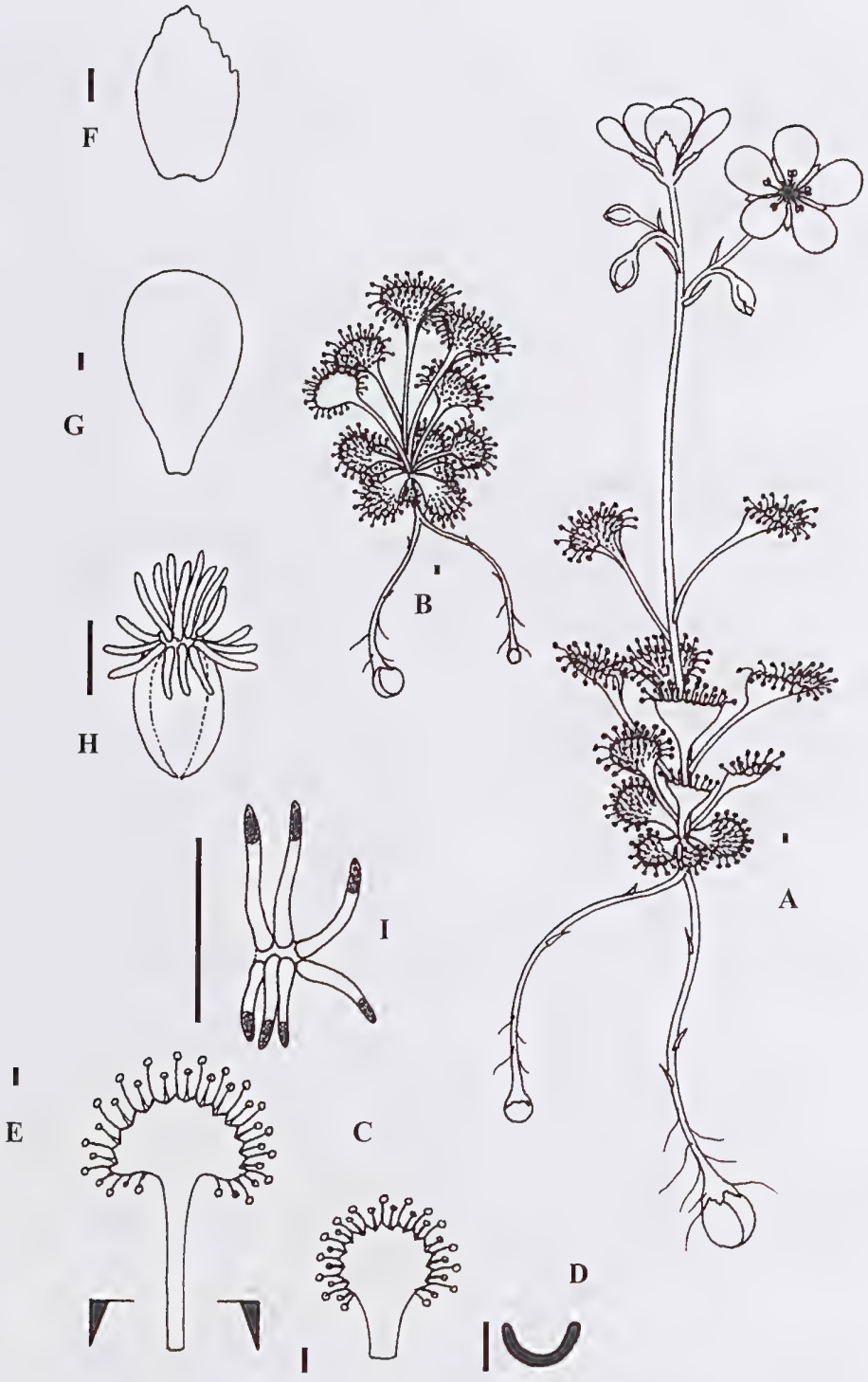

Figure 3. *Drosera monticola.* A.–non-flowering plant; B.–flowering plant; C.–basal leaf lamina; D.–petiole section; E.–cauline leaf lamina; F.–sepal; G.–petal; H.–ovary-styles; I.–style-stigmas, enlarged. Scale bars for all = 1 mm. Drawn by A. Lowrie in 1990 from live material from Toolbrunup Peak, Western Australia, voucher *A. Lowrie* 530.

Affinities. Considered to be most similar to *Drosera purpurascens*. *D. monticola* differs from *D. purpurascens* by having plants forming compact colonies, with additional below-ground stolons and tubers present at maturity but lacking a prostrate stolon on the soil surface, and pale pink flowers. It also has a different distribution, occurring only on the summits in the Stirling Range.

Notes. Under normal conditions, *Drosera monticola* rarely flowers, and then only on a very small number of plants even in the largest of populations. However, after bushfires, flowering occurs en masse.

Collection of mature seed from this species has been unattainable up to the time of this paper publication due to the infrequency of its flowering regime. However, a few well developed but still a little immature seeds were available from the *A. Lowrie* 530 gathering. This immature seed material has been used for the SEM micrographs and description data to gain some understanding as to its approximate size and likely testa cell pattern.

Drosera platypoda Turcz., *Bull. Soc. Imp. Nat. Moscou* 27(2): 343 (1854). *Type:* "Nova Hollandia [Australia], Drum. [*J. Drummond*] V [5th coll.] n. 281." (*iso:* K, MEL).

Drosera flabellata Benth., *Fl. Austral.* 2: 464 (1864). *Type:* " W. Australia. towards Cape Riche, *Drummond,* 5th coll. n. 281." (*iso:* FL, K).

Illustrations. L. Diels, *Pflanzenr.* 26: 127, fig. 40, D, (1906); R. Erickson, *Plants of Prey in Australia* 32; plate 5, 1–4 (1968).

Photographs. A. Lowrie, *Carnivorous Plants of Australia* vol. 1, 119 A–C (1987).

A tuberous-rooted *perennial herb*; stem solitary, erect, glabrous, 15–20 cm tall, with a flat basal rosette of leaves and alternate cauline leaves. *Tuber* orange, obovoid, slightly laterally compressed, *c.* 10 mm long, *c.* 7 mm diam., enclosed in brown papery sheaths and again enclosed in a mass of old coarse root fibre; stolon rarely completely vertical (below ground), *c.* 18 cm long. *Basal leaves* petiole flat, 5–9 mm long, dilating, 0.5–2 to 1–3 mm wide, adaxial surface in the upper parts with insect-trapping retentive glands around the margins and smaller glands within; lamina flabellate, 2.5–5 mm long, 4–9 mm wide. *Cauline leaves* not appressed, with the petiole and lamina slightly folded and rolled along their length forming an open-sided cone-like configuration; lamina similar in size and shape to that of the basal leaves. *Inflorescence* a simple raceme or 2–4-branched corymb, usually terminal but sometimes subterminal, 7–12 cm long (including scape), glabrous; 8–35-flowered; pedicels 5–10 mm long, glabrous. *Sepals* green, broadly ovate, acute, 3.5–4.5 mm long, 1.5–3 mm wide, margins entire, apex sometimes slightly dentate, densely covered with minute papillae, densely black dotted. *Petals* white, obovate, apex truncate and slightly crenate, 7.5–10 mm long, 5–8 mm wide. *Stamens* 5, 2.5–3 mm long; filaments and anthers white, pollen yellow. *Ovary* dark red, subglobose, *c.* 1 mm long, *c.* 1.8 mm diam. at anthesis, papillose; carpels 3, bilobed. *Styles* 3, white, reddish at base, *c.* 1.5 mm long, each divided from the base into many long terete segments, each segment rarely dividing again; stigmas slightly swollen and rounded at the apex of each style segment. *Fruit* obovoid, 3–3.5 mm long, 3–3.5 mm diam., containing *c.* 100 seeds. *Seeds* dark brown, variably shaped but ± turbinate, testa cell pattern reticulate with irregular longitudinal dentate ridges, 0.5–0.7 mm long, 0.4–0.5 mm diam. (Figures 4: (species illustration); 11: G–H (seed micrographs); 14: E (schematic life-form illustration))

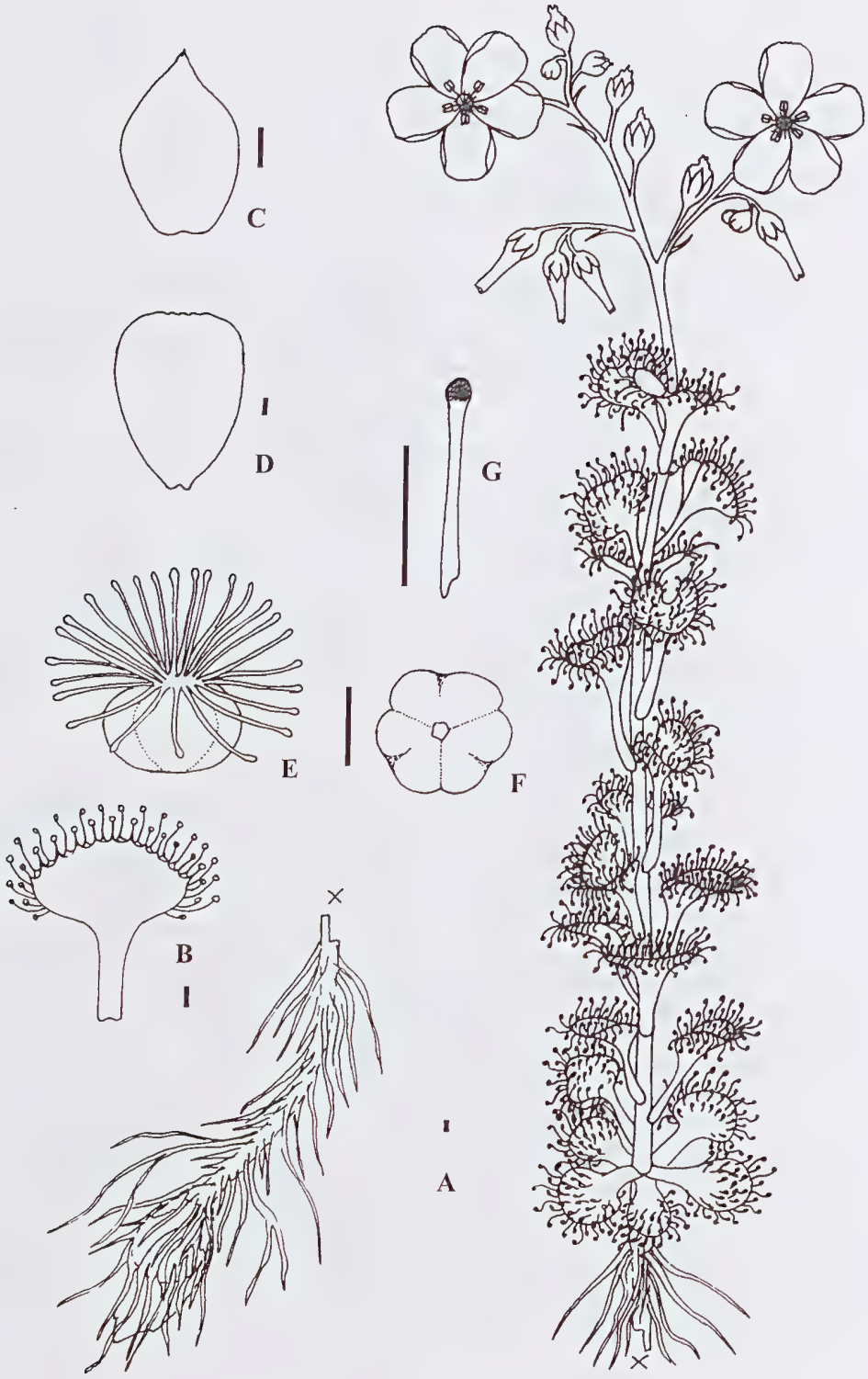

Figure 4. *Drosera platypoda*. A.–plant; B.–basal and cauline leaf lamina; C.–sepal; D.–petal; E.–ovary-styles; F.–ovary, basal view; H.–style-stigma, enlarged. Scale bars for all = 1 mm. Drawn by A. Lowrie in 1984 from live material from Albany, Western Australia, voucher *A. Lowrie* 695.

Other specimens examined. WESTERN AUSTRALIA: Collis Rd, 4 km from Boronia Rd, Frankland National Park, 9 Feb. 1995, *A.R. Annels* 5293A & *R.W. Hearn* (PERTH); along Two Peoples Bay Rd, *c.* 4 miles [6.4 km] W of Two Peoples Bay Wildlife Reserve, 18 Sep. 1974, *L. DeBuhr* 3646 (PERTH); 18 miles [28.8 km] S of Margaret River on Augusta to Margaret River road, 19 Oct. 1974, *L. DeBuhr* 4176 (PERTH); Chester Pass, Toolbrunup, 22 Oct. 1961, *F.* [Rica] *Erickson s.n.* (PERTH); Manjimup side of Inlet River, 22 Sep. 1970, *D. Forman* 46 (PERTH); Chester Pass, 15 miles [24 km] N of King River, 1 Oct. 1963, *T.Y. Harris* 4176 (PERTH); Mersea Lake, Wilgarup, Nov. 1962, *W.A. Laneragan s.n.* (PERTH); on Yellanup Rd, N of Albany, 20 Oct. 1992, *A. Lowrie* 695 (MEL, PERTH); on Parker Brook Rd, NW of Albany, 8 Oct. 1996, *A. Lowrie* 1589 (MEL, PERTH); Palgarup, N of Manjimup, 9 Oct. 1996, *A. Lowrie* 1594 (MEL, PERTH); Cape Riche homestead *c.* 70 miles [112 km] E of Albany, 14 Aug. 1964, *N. Marchant* 6488 (PERTH); Pfeiffer Rd, 4 miles [6.4 km] N of Hassel Highway E of Albany, 12 Sep. 1974, *N. Marchant* 74310 (PERTH); Scott River National Park, 20 Sep. 1990, *C.J. Robinson* 109 (PERTH); 2 km SE of Wedge Hill, Stirling Range, 25 Sep. 1979, *J. Taylor et al.* 840 (PERTH).

Distribution. Extends from Manjimup south-west to the Scott River area and east to Cape Riche.

Habitat. Drosera platypoda grows in saturated winter wet grey sandy soils amongst low shrubs on heathland.

Flowering period. October.

Conservation status. Drosera platypoda is a common species in the Albany region, is locally common near Manjimup, and is known from several national parks. It is currently not under threat.

Etymology. The epithet is from the Greek *platys* – flat and *podos* – foot, in reference to the flat basal rosette of leaves appressed to the soil surface.

Affinities. Drosera platypoda differs from all species in the *D. stolonifera* complex by having a solitary, non-branching, erect major axis bearing only alternate leaves and a terminal inflorescence.

Notes. Both *Drosera platypoda* and *D. fimbriata* encase their dormant tubers in papery sheaths as well as a layer of coarse dry root fibre. This root fibre also encases the stolon almost to the soil surface. When the stolon recedes to its tuber at the start of dormancy, a narrow tube-like passage remains through the root fibre. In the following growing season, the new plant stolon will grow back to the soil surface via this passage.

Examination of old field specimens of *Drosera platypoda* has revealed an interesting feature of this passage through the root fibre. Scattered along its length are small secondary tubers. These secondary tubers appear to be produced only in good growing seasons. When dormancy is broken, the stolons of the secondary tubers grow out through the mass of root fibre and then vertically to the soil surface. This results in a small compact colony of plants that have been produced asexually from one parent. All plants in such a colony are interconnected to the same root system. Although each plant functions as an individual, the connecting root mass persists.

Drosera porrecta Lehm., *Nov. Stirp. Pug.* 8: 41 (1844). – *Drosera stolonifera* subsp. *porrecta* (Lehm.) Marchant & Lowrie, *Kew Bulletin* 47: 320 (1992). *Type:* "Crescit in locis arenosis montis Eiza mountain [Mount Eliza] (Perth) [Western Australia]. (Herb. *Preiss.* no. 1985)." (*iso:* K, MEL 96886, 96891 & 96893, P).

Illustrations. P. Nikulinski, *Fl. Australia* 8,: 42, fig. 11, (1982) [as *Drosera stolonifera* subsp. *stolonifera*]; R. Erickson, *Plants of Prey in Australia*, plate 4: centre page (1968).

Photographs. A. Lowrie, *Carnivorous Plants of Australia* vol. 1, 139 A–C (1987).

A tuberous-rooted *perennial herb* with (1) 2 or 3 basal rosettes of leaves with internodes 10–20 mm long, lowermost rosette (or solitary rosette) always above the soil surface, cauline leaves in many whorls of 3–5 along erect and lateral stems with internodes 12–30 mm long; non-flowering plants erect, up to 45 cm tall, with solitary main stem or very rarely with 2–4 major stems of a similar length arising (side by side) from the uppermost basal rosette of leaves; flowering plants generally up to 15 cm tall (excluding inflorescence), sometimes taller, with (1) 2 or 3 semi-erect leafy main stems arising from the centre of the uppermost rosette of basal leaves. *Tuber* orange, reniform, *c.* 15 mm long, *c.* 20 mm diam., enclosed in a number of brown papery sheaths; stolon vertical (below ground), *c.* 20 cm long, prostrate stolon absent from the soil surface. *Basal leaves* petiole flat, 4–6 mm long, 1.3–2 to 2–3 mm wide; lamina broadly obovate and flabellate, 3.5–4.5 mm long, 4–6 mm wide, adaxial surface with insect trapping retentive glands around the upper margins and smaller glands within. *Cauline leaves* petiole terete, tapering, 7–22 mm long, 0.2–0.5 mm diam., longitudinally narrowly channeled on the upper side; lamina orbicular with an upper wedge-shaped gap, 5–10 mm diam., 2 sides of the removed wedge section gap arranged almost touching to form lamina into a concave cone-shape, mouth of cone facing outward and slightly up from the erect major axis, with insect trapping retentive glands around the margins and smaller glands within. *Inflorescences* of simple racemes or 2–4-branched corymbs, a major one arising from the uppermost basal rosette of leaves and shorter lateral ones from any whorl of leaves scattered along the main lateral stems; racemes or corymbs 3.5–14 cm long (including scape), 25– to over 100-flowered, scape and pedicels with scattered minute glands; pedicels 4–12 mm long. *Sepals* green, elliptic or ovate, apex acute, 3.5–5.5 mm long, 2–2.5 mm wide, margins entire, apex slightly dentate, adaxial surface densely black-dotted, glabrous. *Petals* white, obovate, apex truncate, 5–6.5 mm long, 3–4 mm wide. *Stamens* 5, 1.5–2.5 mm long; filaments white; anthers and pollen yellow. *Ovary* green, subglobose, *c.* 0.7 mm long, *c.* 1.3 mm diam. at anthesis. *Styles* 3, greenish white, *c.* 1 mm long, each divided into many terete tapering segments, some flattened along their length, curved out and upwards from their base and arranged in a whorl, the remainder terete, tapering and erect in the centre of the whorl; stigmas simply formed at the apex of each style segment. *Fruit* obovoid, 2–2.5 mm long, 2–2.4 mm diam., containing 20–28 seeds. *Seeds* black, broadly obovoid to subglobose, testa cell pattern ± honeycombed, reticulate, cells mostly hexagonal, others irregularly tetragonal, ridges and cell floors smooth, 0.4–0.5 mm long, 0.4–0.5 mm diam. (Figures 5: (species illustration); 12: A–B (seed micrographs); 14: F & G (schematic life-form illustrations))

Other specimens examined. WESTERN AUSTRALIA: Claremont, July–Aug. 1900, *C. Andrews s.n.* (PERTH); W of Three Springs, 28 June 1970, *A. M. Ashby* 3247 (PERTH); 32.7 miles [59 km] from Arrowsmith River towards Three Springs on Dongara–Three Springs road, 22 Sep. 1968, *E. M. Canning s.n.* (PERTH); S shore of Mt Henry Spit, Canning River foreshore, 13 Aug. 1974, *M.L. Clark* 58 (PERTH); 60 m from W shore of Mt Henry Spit, Canning River foreshore, 13 Aug. 1974, *M.L. Clark* 61 (PERTH); 20 m from SW corner of Mt Henry Spit, Canning River foreshore, 13 Aug. 1974, *M.L. Clark* 63 (PERTH); Canning Mills Rd, Roleystone, 24 July 1978, *R.J. Cranfield* 289 (PERTH); Kings Park, Perth, 11 Aug. 1920, *C. A. Gardner s.n.* (PERTH); North Fremantle, 10 July 1897, *R. Helms s.n.* (PERTH); North Fremantle, Swan

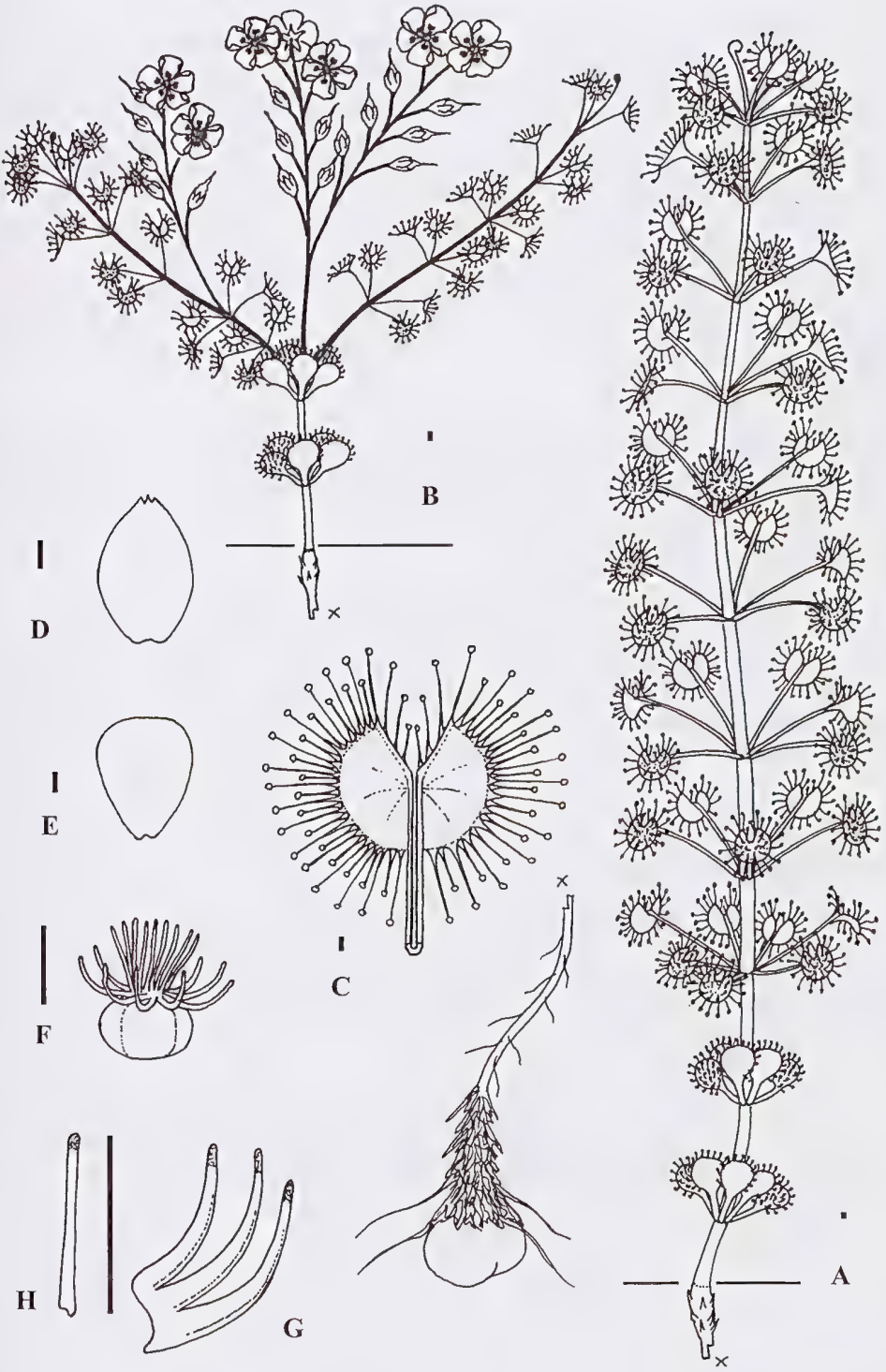

Figure 5. *Drosera porrecta.* A.–non-flowering plant; B.–flowering plant; C.–cauline leaf lamina; D.–sepal; E.–petal; F.–ovary-styles; G.–whorled style-stigmas, enlarged; G.–erect style-stigma, enlarged. Scale bars for all = 1 mm, except A. & B. = 2 mm. Drawn by A. Lowrie in 1984 from live material from north of Cataby, Western Australia, voucher *A. Lowrie* 1791.

River [specimen marked A.], 17 July 1897, *R. Helms s.n.* (PERTH); Cottesloe, 22 July 1897, *B. Helms s.n.* (PERTH); Leederville, 8 Aug. 1897, *R. Helms s.n.* (PERTH); near Perth, Swan River, 8 Aug. 1897, *R. Helms s.n.* (PERTH); Pinjarra, [specimen marked A.], 23 Sep. 1897, *B. Helms s.n.* (PERTH); Darlington, *R. Helms s.n.*, spring [Sep.] 1898, *R. Helms s.n.* (PERTH); on Brand Highway, 4.8 km N of Cataby, 20 Aug. 1997, *A. Lowrie* 1791 (MEL, PERTH); Coomallo, 57.3 km N of Cataby, 20 Aug. 1997, *A. Lowrie* 1794 (MEL, PERTH); *c.* 30 km N of Eneabba, 20 Aug. 1997, *A. Lowrie* 1799 (MEL, PERTH); Mount Eliza, Kings Park, Perth [type location], 31 Aug. 1997, *A. Lowrie* 1830 (MEL, PERTH); Burnside Rd, SE of Pinjarra, 21 Sep. 1997, *A. Lowrie* 1875 (MEL, PERTH); W side of Mount Cooke, 2 Oct. 1997, *A. Lowrie* 1892 (MEL, PERTH); Moores Rd, Pinjarra, 1 Sep. 2001, *A. Lowrie* 2639 (MEL, PERTH); Karrakatta Cemetery, 16 July 1965, *N. Marchant* 6532 (PERTH); Smith's Mill, Darling Range, 6 Aug. 1898, *A. Morrison s.n.* (PERTH).

Distribution. Extends from Eneabba and Marchagee south to the Pinjarra area, including the Darling Range southwards to Mt Cooke.

Habitat. Drosera porrecta grows in well drained deep white or beige sandy soils amongst low shrubs on heathland on the northern sand plains. In the Perth region it occurs in *Banksia* woodlands in sandy soils over limestone on the coastal plain; also in sand near winter-wet swamp margins as well as adjoining open Jarrah woodland in the Pinjarra region; and in sand mixed with a little laterite in Jarrah woodlands in the Darling Range.

Flowering period. July to September.

Conservation status. Drosera porrecta is a common species, especially between Eneabba and Cataby, and is currently not under threat.

Etymology. From the Latin *porrectus* meaning extending outwardly. It is unclear as to what the author's epithet was to signify but possibly refers to the leafy growth and inflorescences arising from the basal whorl of leaves as found on the type material specimens.

Affinities. Non-flowering specimens of *Drosera porrecta* differ from all species in the *D. stolonifera* complex by having a solitary erect major axis stem bearing whorls of leaves along the length or, when very rarely 2–4 major axis stems of a similar length occur, these are arranged side by side in the uppermost basal rosette of leaves. This later condition maybe in response to insect damage to juvenile apical leaf tissue early in the growing season.

Flowering specimens of *Drosera porrecta* are closest to *D. stolonifera* in size and appearance. *D. porrecta* differs from *D. stolonifera* (whose contrasting characters are given in parenthesis) by lacking a prostrate stolon on the soil surface (prostrate stolon commonly present); having an erect lower major axis stem with mostly 2 or 3, rarely 1, obovate and flabellate leaved basal rosettes with distinctive internodes and the lowermost basal rosette always positioned above the soil surface (basal rosette solitary, always appressed to the soil surface); whorled leaved stems arising from the uppermost basal rosette of leaves on both flowering or non-flowering specimens (whorled leaved stems arising from the lowermost basal rosette); major inflorescence always arising from the terminal basal rosette (major inflorescence arising from the basal rosette); and lamina of uppermost whorled leaves along erect and lateral major axis stems circular with an upper wedge-shaped gap (lamina of whorled leaves along uppermost erect and lateral major axis stems reniform).

Notes. The K material of *Preiss* 1985 is on a shared sheet of seven plants, of which three are *Drosera porrecta* (one top right and two bottom right). The remaining specimens on the sheet, labeled "Swan River, N. Holland, *Drummond*", are *D. stolonifera.*

Diels (1906) agreed with Planchon (1848) that *Drosera porrecta* and *D. stolonifera* should be treated as the same species. Under Diels' treatment of *D. stolonifera* he noted the following:

> "Branching different, for which *cl.* Lehmann on *D. porrecta* Lehm. says it is in the habit of producing. Comparing (*Plant. Preiss.* 1 (1845) 252 [*D. porrecta*], [with] 253 [*D. stolonifera*]) the different branching is found in one and the same species and both species are found in one and the same locality. Therefore that species [*D. porrecta*] *cl.* Planchon in Ann. Sci. Nat. 3. ser IX (1848) 300 is rightly rejected."

Here Diels noted that the branching systems of *Drosera stolonifera* and *D. porrecta* according to Lehmann's descriptions were similar. Flowering specimens of *D. porrecta* and *D. stolonifera* do have more or less similar branching strategies. That is, a major inflorescence arising from a basal rosette of leaves along with lateral semi-erect whorled leafy stems which often supporting additional minor inflorescences. Both Diels and Planchon's assumption that *D. porrecta* and *D. stolonifera* were one and the same species was an acceptable conclusion for their time, bearing in mind that they were only ever equipped with dried material and minimal field data notation to work with.

The facts are, *Drosera porrecta* only produces similar branching to *D. stolonifera* when it flowers. Non-flowering specimens of *D. porrecta* are commonly an erect solitary plant consisting of major axis up to 45 cm tall, bearing 1 to 3 basal rosettes with broadly obovate and flabellate leaves situated above the soil surface, followed by whorled leaves supporting circular lamina with a small apical gap towards the apex with well defined internodes between basal rosettes and whorled leaves. In contrast *Drosera stolonifera* consists of a solitary basal rosette of transversely elliptic and depressed ovate leaves situated on the soil surface. Commonly 2 to 5, and sometimes more, lateral semi-erect stems up to 25 cm tall bearing whorled leaves supporting reniform lamina arise from this basal rosette, whether flowering or not.

Lehmann also recorded in his description that *Drosera porrecta* differs from *D. stolonifera* "chiefly in fact with respect to flowering at all times out of whorled leaves higher, by no means in fact from whorls in lower part."

What Lehmann was describing here was the position of the basal rosette, from which the major inflorescence as well as the leafy stem(s) arise, in relation to the soil surface. In the case of *Drosera porrecta* it is always situated above the soil surface whether flowering or not. When more than 1 basal rosette is present, and groups of 2 or 3 basal rosettes are common, the uppermost rosette supports the major inflorescence as well as the erect leafy stem(s) growth, and along with the lowermost rosette of the group as a whole, are always situated well above the soil surface. In contrast, *D. stolonifera* only ever has a solitary basal rosette supporting the major inflorescence as well as the erect leafy stems growth, and this rosette is always situated on the soil surface whether flowering or not.

Diels incorrectly recorded that the Preiss' collections of *Drosera porrecta* and *D. stolonifera* recorded by Lehmann in his paper are found at the same location. *D. porrecta* (*Preiss* 1985) was collected from Mount Eliza, overlooking Perth on the 20 August 1839, and *D. stolonifera* (*Preiss* 1984) was collected from Peninsula, Perth on 31 August 1839.

The Peninsula, as it was once unofficially called (now in the suburb of Maylands) was originally named Point Garling by Capt. Sir James Stirling in 1827 on his exploration of the Swan River. Frederick Garling was an artist on the *H.M.S. Success* who accompanied him on his exploration. A distance of 6 km exists between Priess' two collection stations.

Drosera porrecta still occurs at the type location on Mount Eliza in Kings Park, located above the City of Perth, growing with other undisturbed native vegetation in open *Banksia* woodland, but *D. stolonifera* has not been recorded there. *D. stolonifera* no longer occurs in the degraded remnant vegetation on the peninsula in Maylands. The lay of the land and remnant paperbark trees (*Melaleuca* species) on the foreshore of the Swan River, suggest a large part of the peninsula was mostly swampland heath.

Prior to urbanization, Preiss' *D. stolonifera* collection area on the peninsula may have been similar to an area that once occurred at Canning Vale (*c.* 16 km south-east of Perth). Today unfortunately this area too has been drained and is largely urbanized. Thirty five years ago however, Canning Vale supported huge areas of swampland heath which were extremely rich in a vast array of species, especially triggerplants, orchids and carnivorous plants. *D. stolonifera* was a common species there growing around the bases of the paperbark trees in black peaty sand. Now only a few small remnant bushland areas remain, one of which, next to a shopping complex car-park still supports a colony of *D. stolonifera* (*A. Lowrie* 2634).

South-east of Pinjarra in a similar swampland heath, specimens of *Drosera stolonifera (A. Lowrie* 1876) have been found growing within 3 metres of *D. porrecta (A. Lowrie* 1875). without apparently hybridising, providing further justification to treat these taxa as distinct entities. At this location *D. stolonifera* favoured the wetter parts of the habitat whereas the majority of D. *porrecta* preferred the higher better drained soils.

One half of this south-east of Pinjarra habitat had been burnt the previous summer. *Drosera stolonifera* was found in the un-burnt area with a few *D. porrecta* plants and only one *D. stolonifera* was found in flower between the two species. All specimens of *D. porrecta* on the burnt side of the habitat however, where *D. stolonifera* was absent, were in flower, providing evidence that a bushfire (when the species is dormant in summer) stimulates mass flowering in spring.

Recently *Drosera porrecta* (*A. Lowrie* 2639) and *D. stolonifera* (*A. Lowrie* 2640), both flowering and growing intermixed with each other, have been observed at another location which was recently burnt near Pinjarra. Here *D. porrecta* was nearing the end of anthesis while *D. stolonifera* was at the beginning of anthesis. Both species displayed white flowers which freely emitted a very sweetly perfumed pheromone. I discovered a distinct difference to the nose in the type of perfume each species produced. I also established from the fully opened flowers of each species (it was late in the afternoon and both species flowers had been open since early morning) that *D. stolonifera* was far more strongly perfumed than *D. porrecta.* Again, no hybrids were observed between these two species.

Drosera prostrata (Marchant & Lowrie) Lowrie, *comb. nov.*

Drosera stolonifera subsp. *prostrata* Marchant & Lowrie, *Kew Bulletin* 47: 320–321 (1992). *Type:* Kalbarri, on the road to The Loop, in yellow and white sandy soils between low shrubs on heathland, Western Australia, 14 June 1984, *A. Lowrie* 84/073 (*holo:* PERTH 04179005; *iso:* PERTH 02345005).

Photographs. A. Lowrie, *Carnivorous Plants of Australia* vol. 1,143 A–C (1987).

A tuberous-rooted *perennial herb* with 4–5 prostrate lateral stems (with a few stems sometimes branching further along their length) 3.5–15 cm long, radiating out from the centre of a rarely formed basal rosette of 3 or 4 leaves; foliage reddish, cauline leaves in many whorls of 3–5 along the prostrate stems, each whorl oriented so that the leaves are all at an equal height above the soil surface, distance between

internodes 6–10 mm long. *Tuber* orange, globose, *c.* 8 mm diam., enclosed in a number of brown papery sheaths; stolon vertical (below ground), *c.* 10 cm long, prostrate stolon (on soil surface) absent. *Basal leaves* (when present) spathulate (including the petiole); lamina 2–5.5 mm long, 0.8–1.2 mm wide, adaxial surface with insect trapping retentive glands around the margins and smaller glands within. *Cauline leaves* petiole dilated towards the lamina, 1.7–3 mm long, 0.2–0.3 to 0.4–0.8 mm wide; lamina broadly obovate, 2–3.5 mm long, 2.6–5 mm wide, with insect trapping retentive glands around the margins and smaller glands within. *Inflorescence* of 1–4 panicles, 1–9-flowered, 3–5.5 cm long (including scape); scape yellowish green with scattered minute sessile glands; pedicels 5–14 mm long. *Sepals* yellowish green, narrowly ovate, acute, 4.5–5 mm long, 1.5–2 mm wide, margins entire, apex serrate, adaxial surface with scattered minute sessile glands, black dotted. *Petals* white, narrowly obovate, apex truncate crenate and sometimes retuse, 5–6 mm long, 2–2.5 mm wide. *Stamens* 5, 1.5–2 mm long; filaments white; anthers and pollen yellow. *Ovary* green, globose, *c.* 1.5 mm diam. at anthesis. *Styles* 3, white, *c.* 1 mm long, each divided into many terete segments; stigmas simply formed at the apex of each style segment. *Fruit* obovoid, 2.5–3.5 mm long, 3–4 mm diam., containing *c.* 20 seeds. *Seeds* brown (just before dispersal from the seed capsule), black (on dispersal), variably shaped from subglobose to ellipsoid, apical pole indented, basal pole funicle barely projected beyond overall seed shape, testa cell pattern colliculate at apex, remainder reticulate-foveate, ridges and cell floors smooth, 0.6–0.8 mm long, 0.5–0.6 mm wide. (Figures 6: (species illustration); 12: C–D (seed micrographs); 14: H (schematic life-form illustration))

Other specimens examined. WESTERN AUSTRALIA: 29 km Tamala road, on road to Tamala from the turnoff from the Overlander Roadhouse-Monkey Mia road, 12 Aug. 1976, *H. Demarz* 6121 (PERTH); Kalbarri, near gun club, 18 Aug. 1974, *R. Garraty* 511 (PERTH); 46.4 km W of Great Northern Highway on sandy track to Zuytdorp more or less parallel to state barrier fence, 26 Aug. 1994, *G.J. Keighery & N. Gibson* 1453 (PERTH); 59.3 km W of Great Northern Highway on sandy track to Zuytdorp more or less parallel to state barrier fence, 26 Aug. 1994, *G.J. Keighery & N. Gibson* 1535 (PERTH); 16.5 km W of Binnu, 21 Aug. 1997, *A. Lowrie* 1813 (MEL, PERTH); 17.3 km W of Binnu, 21 Aug. 1997, *A. Lowrie* 1815 (MEL, PERTH); 20 km N of Junga Dam, Kalbarri National Park, 11 May 1968, *P.G. Wilson* 6699 (PERTH); Tamala, 12 Aug. 1976, *E. Wittwer* 1807 (PERTH).

Distribution. Extends from the Tamala area (near Shark Bay) south to near Binnu.

Habitat. Drosera prostrata grows in yellow sand, yellow sand sometimes mixed with a little white sand and red sand soils amongst low shrubs on heathland on the northern sand plains.

Flowering period. May to June.

Conservation status. Drosera prostrata is locally abundant at scattered locations over its range, which includes the Kalbarri National Park, and is currently not under threat.

Etymology. The epithet from the Latin *prostratus* meaning prostrate, refers to this species lateral leafy stems prostrate growth habit.

Affinities. Drosera prostrata differs from all species in the *D. stolonifera* complex by its prostrate growth habit.

Notes. D. prostrata (*G.J. Keighery & N. Gibson* 1453, 1535 and *A. Lowrie* 1815) coexists with *Drosera humilis* (recorded but not vouchered) at the *G.J. Keighery & N. Gibson* 1453, 1535 locations near the Zuytdorp National Park (pers. comm. Neil Gibson), and in the Binnu region (*A. Lowrie* 1816) without apparently hybridizing, providing further justification to treat both taxa as distinct entities.

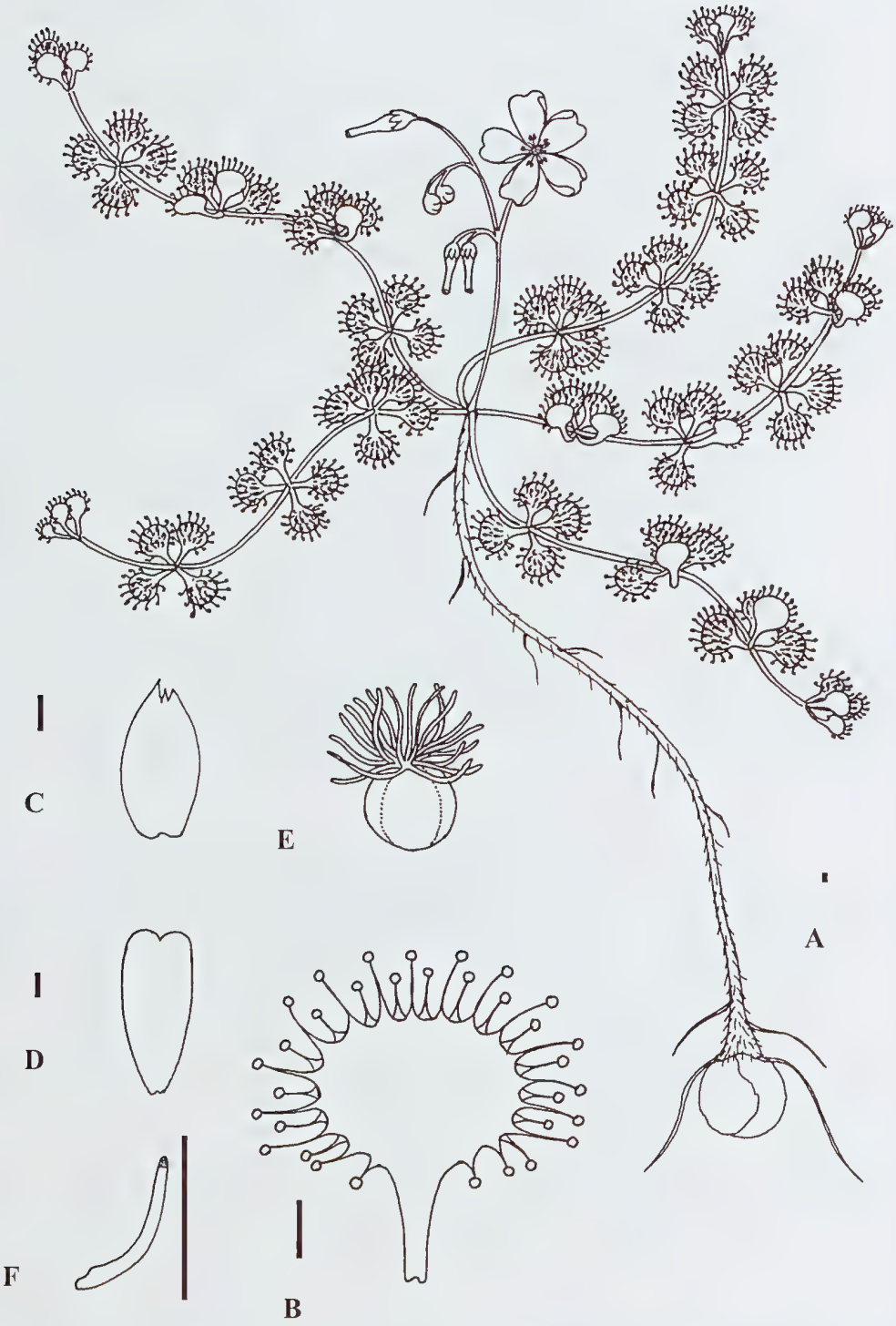

Figure 6. *Drosera prostrata.* A.–plant; B.–cauline leaf lamina; C.–sepal; D.–petal; E.–ovary-styles; F.–style-stigma, enlarged. Scale bars for all = 1 mm. Drawn by A. Lowrie in 1984 from live material from the type location, Western Australia, voucher *A. Lowrie* 84/073.

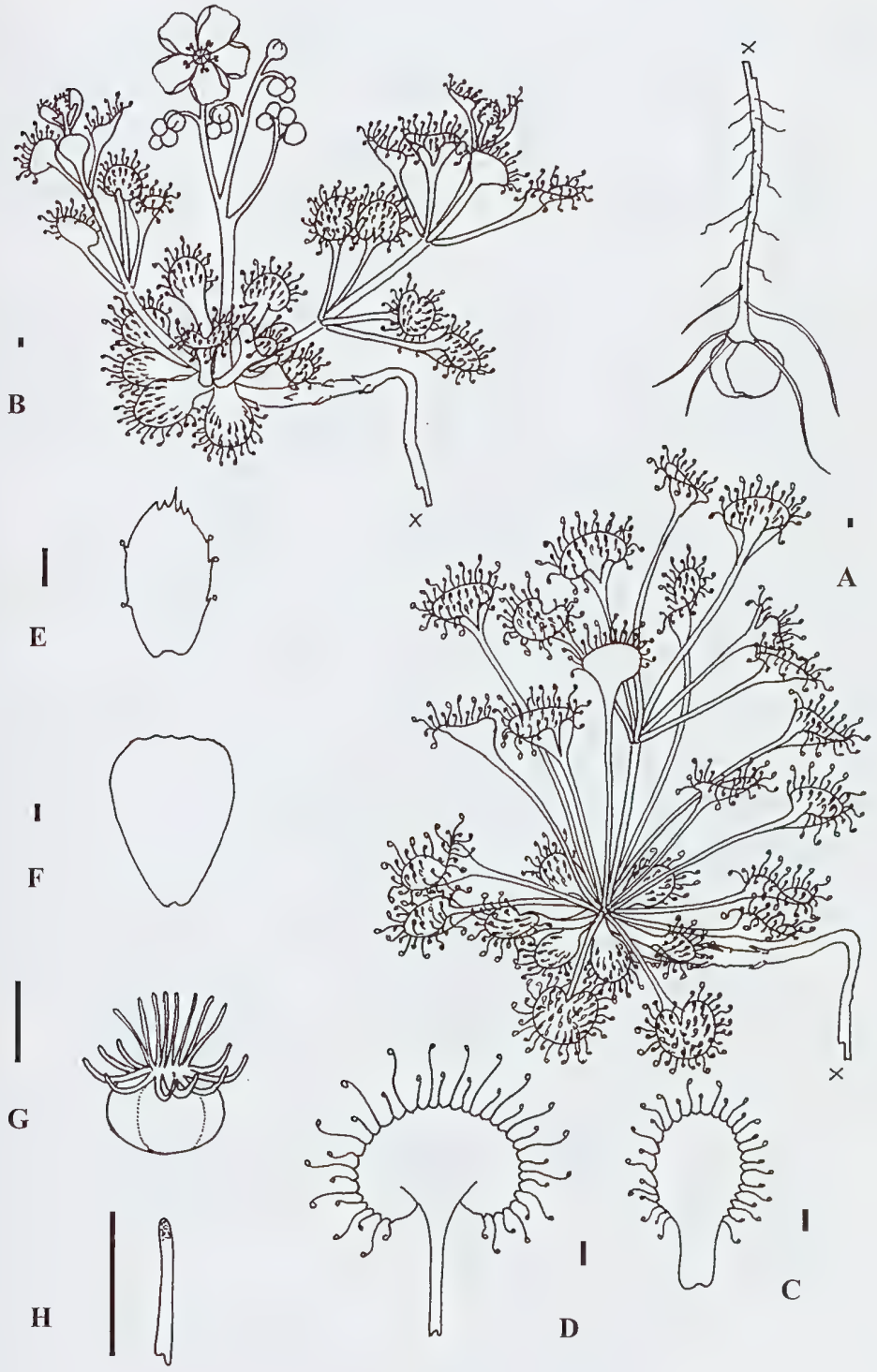

Figure 7. *Drosera purpurascens.* A.–non-flowering plant; B.–flowering plant; C.–basal leaf lamina; D.–cauline leaf lamina; E.–sepal; F.–petal; G.–ovary-styles; H.–style-stigma, enlarged. Scale bars for all = 1 mm. Drawn by A. Lowrie in 1984 from live material from Kojonup, Western Australia, voucher *A. Lowrie* 292.

Drosera purpurascens Schlott., *Bonplandia* 4(7): 111 (1856). *Type:* "Schedula Preissiana Nr. 1977. In solo turfos-arenoso prope montem "Wuljenap (Plantagenet) [Wolyamup Hill, 33°32'S, 117°54'E, *c.* 35 km NE of Katanning, Western Australia] *non* Mt Willyung [Albany area] *sensu* Marchant (1982) or Wuljenup *sensu* Lehmann (1844) and Bentham (1864)]" L. Preiss legit." [*L. Preiss* 1977] (*iso:* P).

Drosera stolonifera subsp. *compacta* N.G. Marchant, *Fl. Australia* 8: 384 (1982). *Type:* 2 miles [3.2 km] SW of Ongerup, Western Australia, 28 September 1963, *K.R. Newbey* 977 (*holo:* PERTH 06230946).

Photographs. A. Lowrie, *Carnivorous Plants of Australia* vol. 1, 131 A–C (1987).

A tuberous-rooted *perennial herb*, compact, with 1 erect or 2–5 semi-erect lateral stems 3–10 cm long (mostly *c.* 3 cm long at anthesis) arising from the centre of a small basal rosette of leaves; foliage reddish, cauline leaves with rather long petioles in whorls along the erect or semi-erect main stems as well as from the base of the stems. *Tuber* red, globose, *c.* 8 mm diam., enclosed in a number of brown papery sheaths; stolon vertical (below ground), *c.* 12 cm long, stolon prostrate (on soil surface) *c.* 10 cm long. *Lowermost basal leaves* petiole flat, 4–5 mm long, 1.5–2 to 2.5–4 mm wide; lamina spathulate (including the petiole), 4–9 mm long, 2.5–5 mm wide, adaxial surface with insect trapping retentive glands around the margins and smaller glands within. *Uppermost basal leaves* petiole flat, 4.5–10 mm long, 0.5–0.7 to 1–1.5 mm wide; lamina flabellate, 3–4 mm long, 4–4.5 mm wide, adaxial surface with insect trapping retentive glands around the margins and smaller glands within. *Cauline leaves* petiole 8–30 mm long, 0.4–0.6 mm wide, longitudinally channeled on upper side; lamina reniform, 2–3.5 mm long, 3–6 mm wide, lamina margins rolled towards the centre forming an open-sided, concave, cone-like arrangement, with insect-trapping retentive glands around the margins and smaller glands within. *Inflorescence* of panicles, each 4–14 cm long (mostly 4–6 mm long including the scape), 3–30-flowered, arising from the centre of the basal rosette of leaves, with minute glands few and scattered on lower parts but becoming denser on the upper parts and pedicels; pedicels 1.5–4 mm long. *Sepals* green, ovate or elliptic, acute, 3.5–4.5 mm long, 1.5–2 mm wide, margins irregularly dentate with a few glands, apex serrate, adaxial surface with a few scattered minute sessile glands, otherwise glabrous, black dotted. *Petals* white, obovate, apex truncate and crenate, 9–10 mm long, 6–7 mm wide. *Stamens* 5, 2–2.5 mm long; filaments and anthers white, pollen yellow. *Ovary* green, subglobose, *c.* 0.8 mm long, *c.* 1.5 mm diam. at anthesis. *Styles* 3, white, *c.* 1 mm long, each divided into many terete segments, half arranged in a whorl and curved out and upwards from their base, remainder erect in the centre of the whorl; stigmas simply formed at the apex of each style segment. *Fruit* obovoid, 2.5–3 mm long, 3–3.5 mm diam., containing *c.* 14 seeds. *Seeds* black, ± subglobose, apical pole indented, basal pole funicle *c.* 0.06 mm long, *c.* 0.09 mm diam., testa cell pattern reticulate, foveate, ridges and cell floors slightly irregularly undulate, *c.* 0.5 mm long, *c.* 0.45 mm diam. (Figures 7: (species illustration); 12: E–F (seed micrographs); 14: I & J (schematic life-form illustrations))

Other specimens examined. WESTERN AUSTRALIA: 1 km N of Nutcracker Rd, 15 km NNW of Denmark, 21 Oct. 1991, *A.R. Annels* 1742 (PERTH); Lake Ninijup Reserve, 15 km WSW of Tenterden, 22 Sep. 1993, *A.R. Annels* 3838 (PERTH); Salt River Rd, 2 km E of Cranbrook, 23 Sep. 1994, *W. Bopp* 109 (PERTH); Ledge Beach Rd off Gull Rock Rd, Lower Kalgan, 9 Sep. 1983, *E.J. Croxford* 2887A (ALBANY, PERTH 04420365); 10 miles [16 km] E of Cranbrook along road to Borden, 10 Sep. 1974, *L. DeBuhr* 3573 (PERTH, RSA); W of Kendenup, Oct. 1961, *R. Erickson s.n.* (PERTH); Qualenup North, 35 km W of Kojonup, 20 Sep. 1995, *C. Lewis* 84 (PERTH); on the walk trail to summit of Mt Lindesay, N of Denmark. 18 Aug. 1991, *A. Lowrie* 287 (MEL, PERTH); Albany Highway 20 km N of Kojonup, 17 Aug. 1991, *A. Lowrie* 292 (MEL, PERTH); W side of Mt Cooke, 2 Oct. 1997, *A. Lowrie* 1893 (MEL, PERTH); North East Rd, *c.* 2.5 km W of Albany Highway, 2 Oct. 1997, *A. Lowrie* 1894 (MEL, PERTH); Wolyaming Rd, *c.* 34.4 km E of Katanning [*c.* 6 km south of type location], 3 Oct. 1997, *A. Lowrie* 1915 (MEL, PERTH); 4.7 miles [7.5 km] SW of Chillinup

on Cape Riche Rd, 18 July 1965, *N. Marchant* 6559 (PERTH); 5 miles [8 km] N of Ongerup, 20 Sep. 1972, *K. Newbey* 3581 (PERTH); 16 miles [25.6 km] SE of Ongerup, 13 Sep. 1966, *E.M. Scrymgeour* 980 (PERTH).

Distribution. Extends from Mt Cooke area to north-east of Katanning, south-east to Ongerup and south to Denmark–Albany region.

Habitat. Drosera purpurascens grows in sand-laterite soils on heathland and in stony, sandy clay soils in *Eucalyptus* woodlands.

Flowering period. July to October. Mass flowering occurs after bushfires.

Conservation status. Drosera purpurascens is a common species and is currently not under threat, occurring throughout the Stirling Range National Park.

Etymology. From the Latin *purpurascens* – purplish, in reference to the colour of the glandular hairs on herbarium specimens which in the living state at maturity are reddish.

Affinities. Drosera purpurascens is characterized from all other members of sect. *Stolonifera* by having: compact foliage; lamina of the leafy whorls along the semi-erect lateral stems as well as those from base reniform, with margins rolled towards the centre forming an open-sided, concave, cone-like arrangement; and rather long petioles for the compact size of the plant.

Notes. Schlotthauber (1856) recorded that Lehmann (1844) had falsely attributed the type for *Drosera purpurascens* to his [Lehmann's] *D. stolonifera* [Endl.] #10 treatment and also had produced an exact worded description for this species from Endlicher's (1837) descriptions. Lehmann had also used other exactly worded species descriptions from Endlicher's paper in his own paper. What Schlotthauber was saying was that Lehmann had wrongly placed the type collection for *Drosera purpurascens* along side a *D. stolonifera* collection on his list of cited specimens in his treatment of *D. stolonifera*. Schlotthauber also recorded that Lehmann had copied word for word Endlicher's previously published description for *D. stolonifera* and likewise with other species. Schlotthauber may have been suggesting Lehmann had plagiarized Endlicher's work. Even though Lehmann had used just the short introduction (not the full description) for each of Endlicher's species he did so in Endlicher's exact words. At the end of which he cited Endlicher and the relevant publication he had lifted the wording from.

Drosera purpurascens (*A. Lowrie* 1893) coexists with *D. porrecta* (*A. Lowrie* 1892) on the west side of Mt Cooke, *c.* 40 km south-east of Armadale apparently without hybridizing, providing further justification to treat them as distinct entities genetically isolated from each other. Furthermore, *c.* 10 km to the north east of this Mt Cooke location *D. stolonifera* (*A. Lowrie* 1891) also occurs. Because *D. stolonifera* has been recorded near Mt Cooke, further exploration around Mt Cooke could possibly reveal the presence of all three species growing together at the one location. If this occurred it would further enhance an already outstanding living laboratory for cutting edge genetic studies.

Drosera ramellosa Lehm., *Nov. Stirp. Pug.* 8: 40 (1844). *Type:* "Crescit in locus arenosis humidis prope lacum insulae Rotenest. [Rottnest, Western Australia], (Herb. Preiss. no 1990)." [*Preiss* 1990](*iso:* FI, MEL, S).

Drosera penduliflora Planchon, *Ann. Sci. Nat.* (Paris) ser. 3, 9: 301 (1848). *Type:* "in colonia Swan River [Swan River Colony south-west Western Australia], Drummond in herb. Hook." [*J. Drummond s.n.*](*iso:* K).

Illustrations. L. Diels, *Pflanzenr.* 26: 127, fig. 40 E, (1906); R. Erickson, *Plants of prey in Australia*, plate 5: 5 (after Diels), (1968); P. Nikulinsky, *Fl. Australia* 8: 46, fig. 13 A–E (1982).

Photographs. A. Lowrie, *Carnivorous Plants of Australia* vol. 1, 123 A–C (1987).

A tuberous-rooted *perennial herb;* major axis stem(s) 1–3, mostly 2, erect, glabrous, 4–12 cm tall, with a compact basal rosette of leaves not quite appressed to the soil and alternate leaves along the erect stem(s). *Tuber* orange, obovoid, slightly laterally compressed, *c.* 10 mm long, *c.* 7 mm wide, enclosed in brown papery sheaths; stolon vertical (below ground), *c.* 5 cm long. *Basal leaves* petiole flat, 3.5–6 mm long, dilated towards the lamina, 1–2 to 1.5–3 mm wide; lamina obovate, 3–5 mm long, 3–8 mm wide, adaxial surface in the upper parts with insect trapping retentive glands around the margins and smaller glands within. *Cauline leaves* with petiole and lamina slightly folded and rolled along their length forming an open-sided-cone-like configuration closely appressed to the erect stem; lamina more or less similar in shape to that of basal leaves, with only a little variation in overall size except those near the stem apex always smaller. *Inflorescence* of 1–3 racemes arising from the centre of the basal rosette of leaves; racemes 1.5–4 cm long (including scape), glabrous, 1–3-flowered, scapes and petioles covered with scattered minute sessile glands; pedicels terete, 5–12 mm long. *Sepals* green, ovate-elliptic, 2–4 mm long, 1.5–2 mm wide, margins entire, apex dentate, adaxial surface covered with minute papillae and a few scattered red sessile glands, black dotted. *Petals* white, obovate, apex entire or slightly crenate, 3–5 mm long, 2.5–3 mm wide. *Stamens* 5, 2–2.5 mm long; filaments and anthers white, pollen yellow. *Ovary* green, subglobose, *c.* 1 mm long, *c.* 1.5 mm diam. at anthesis; carpels 3. *Styles* 3, white, *c.* 1 mm long, each divided just up from the base into a small number of thick terete segments; stigmas simple at the apex of each style segment. *Fruit* pendulous, globose-ellipsoid, 5–5.5 mm long, 4–5.5 mm diam., containing *c.* 28 seeds. *Seeds* greyish brown, variably shaped but ± cupiform with a central umbo surrounded by a small flattened apron around the apical pole, testa cell pattern at apical pole ± irregularly colliculate, remainder reticulate, foveate, ridges ± smooth, cell floors ± irregularly undulate, 0.8–1 mm long, 0.7–0.9 mm diam. (Figures 8: (species illustration); 13: A–B (seed micrographs); 14: K (schematic life-form illustration))

Other specimens examined. WESTERN AUSTRALIA: Cannington (Perth), Sep. 1904, *C. Andrews s.n.* (PERTH); 1.5 km W of One Tree Hill, 30 km NE of Eneabba, 7 Sep. 1994, *W. Bopp* 55 (K, PERTH, RNG); along the Cape Le Grand Rd, *c.* 12 miles [19.2 km] E of junction with Israelite Bay Rd, 23 Sep. 1974, *L. DeBuhr* 3737 (PERTH); Kalbarri, near gun club, 18 Aug. 1974, *B. Garraty* 512 (PERTH); Hill River, *c.* 16 miles [24 km] NW of Badgingarra, 1 Sep. 1966, *A.S. George* 7802 (PERTH); Lort River crossing on Ravensthorpe–Esperance road *c.* 60 km W of Esperance, 11 Oct. 1968. *E.N.S. Jackson* 1394 (PERTH); Hay Flat Rd, W of Great Northern Highway, 31 Aug. 1991, *A. Lowrie* 299 (MEL, PERTH); 4.9 miles [7.8 km] S of Mogumber, 23 Aug. 1964, *N. Marchant* 64150 (PERTH); 40 miles [64 km] E of Esperance on Israelite Bay Rd, 14 Sep. 1964, *N. Marchant* 64222 (PERTH); Coragina Rock N of Mt Ragged, 15 Sep. 1971, *N. Marchant* 71426 (PERTH); Coolinup Nature Reserve, 23 Sep 1991, *D.E. Murfet* 1190 (MEL, PERTH); Heinsman Rock, 30 Sep. 1991, *D.E. Murfet* 1233 (MEL, PERTH); Ponier Rock, *c.* 65 km S of Balladonia Motel on Eyre Highway, 13 Sep. 1980, *K Newbey* 7295 (PERTH); Coragina Rock, *c.* 63 km S of Balladonia Motel on Eyre Highway, 16 Sep. 1980, *K Newbey* 7417 (PERTH); 22 km N of coast at Stokes Inlet, 75 km W of Esperance, 27 Sep. 1968, *A.E. Orchard* 1225 (PERTH).

Figure 8. *Drosera ramellosa.* A.–plant; B.–basal and cauline leaf lamina; C.–sepal; D.–petal; E.–stamen; F.–ovary-styles; G.–style-stigmas, enlarged. Scale bars for all = 1 mm, except A = 0.5 mm. Drawn by A. Lowrie in 1984 from live material from Hay Flat Rd, Western Australia, voucher *A. Lowrie* 299.

Distribution. Drosera ramellosa is a widespread species from Kalbarri southwards to Cranbrook and eastwards to Mt Ragged east of Esperance. Large populations commonly occur on the aprons of granite outcrops in inland regions.

Habitat. Drosera ramellosa grows in saturated winter wet grey sandy soils, clayey sand soils or red loam soil amongst low shrubs on the shores of lakes, floodways, watersheds and creek margins as well as in moss on the aprons of granite outcrops.

Flowering period. July to September.

Conservation status. Drosera ramellosa is a common species and is currently not under threat.

Etymology. From the Latin *ramosus* – much branched, in reference to the erect leafy innovations arising from the basal rosette of leaves.

Affinities. Drosera ramellosa differs from all members in the sect. *stolonifera* by having: 1–3 (mostly 2) erect major axis bearing only alternate leaves and inflorescences arising from the basal rosette of leaves bearing pendulous fruit.

Notes. Drosera ramellosa is often found in small compact colonies up to 15 cm diam. Whether this is the product of asexual reproduction, or the result of poor seed dispersal, is unknown.

An unusual but common habitat for *Drosera ramellosa* is on the banks of salt lakes. *D. ramellosa* grows just above the flood level of the salt lake banks in sandy, salt-free, rainwater leached soils.

Much confusion has arisen from Diels' German in translation to English in regard to what habitat the type was collected from by Preiss on Rottnest Island. Diels recorded "Ufer des Sees" which was firstly translated to mean "shore of the sea" when in fact it should have been translated as "bank of the lake".

Drosera rupicola (Marchant) Lowrie, *comb. nov.*

Drosera stolonifera subsp. *rupicola* N. Marchant, *Fl. Australia* 8, 384 (1982). *Type:* Murray Rock, SE of Hyden, W.A. [Western Australia], 22 September 1971, *N. G. Marchant* 71/680 (*holo:* PERTH 06230954).

Illustrations. R. Erickson, *Plants of Prey in Australia*, plate 4: upper left (1968); P. Nikulinsky, *Fl. Australia* 8: 44, fig. 12 A–D (1982).

Photographs. A. Lowrie, *Carnivorous Plants of Australia* vol. 1, 147A,B (1987).

A tuberous-rooted *perennial herb*, with 3–5 semi-erect lateral stems up to 15 cm long mostly arising from the centre of a basal rosette of leaves (which is sometimes absent); foliage mostly golden-green but often reddish or bronze, cauline leaves of the lateral stems in whorls of 3 or 4. *Tuber* red, turbinate, *c.* 30 mm long, *c.* 20 mm diam., enclosed in a number of brown papery sheaths; vertical stolon (below ground), 15–20 cm long, prostrate stolon (when present on soil surface) up to 5cm long. *Basal leaves* petiole flat, 2.5–11 mm long, 1–3 mm to 1.5–5 wide; lamina obovate, 3–9 mm long, 3–10 mm wide, adaxial surface with insect-trapping retentive glands around the margins and smaller glands within. *Cauline leaves* petiole dilated towards the lamina (when flattened), 5–7 mm long, 0.5–2 to 1–3 mm wide, slightly

longitudinally folded, lamina variable throughout, transversely-elliptic to depressed-ovate, 4–10 mm long, 5.5–15 mm wide, with insect trapping retentive glands around the margins and smaller glands within, sides mobile, folding together onto captured insects. *Inflorescences* 1–4 racemes, arising from the basal rosette of leaves and sometimes also from lower axils of the semi-erect stems; racemes 8–10-flowered, sweetly perfumed, 10–12 cm long (including scape); scape green, glabrous; pedicels green, terete, 6–17 mm long, glabrous. *Sepals* green, broadly ovate or elliptic, acute, 2.5–4 mm long, 1.5–2.5 mm wide, margins in lower half entire, remainder and apex irregularly dentate and serrate tipped with a few glands, adaxial surface with a few scattered minute sessile glands, otherwise glabrous. *Petals* white, obovate, apex truncate and crenate 9–10 mm long, 5–6 mm wide. *Stamens* 5, 2.5–3 mm long; filaments and anthers white, pollen yellow. *Ovary* yellow, subglobose, *c.* 1.5 mm long, *c.* 2 mm diam. at anthesis. *Styles* 3, white, red at the base *c.* 1.5 mm long, each divided into many terete segments, lowermost segments almost whorled, branching more than the erect spreading remainder; stigmas forming 1–3 knob-like projections at the apex of each style segment. *Fruit* broadly obovoid, 4.5–5 mm long, 4.5–5 mm diam., containing *c.* 28 seeds. *Seeds* greyish brown, variably shaped within the bounds of a cylindrical or rectangular figure, apical pole truncate, with a central umbo surrounded by a small flattened apron, longitudinal sides to basal pole irregularly undulate, testa cell pattern reticulate, foveate, ridges irregular, cell floors shallow and irregular, 1–1.3 mm long, 0.8–1 mm wide. (Figures 9: (species illustration); 13: C–D (seed micrographs); 14: L (schematic life-form illustration))

Other specimens examined. WESTERN AUSTRALIA: Chingah Hills NW of Muntadgin along road to Muntadgin from junction with Narembeen–Merredin road, 26 Sep. 1974, *L. DeBuhr* 3801 (PERTH); Bushfire Rock, 28 Aug. 1990, *A. Lowrie s.n.* (MEL, PERTH); Borrikin Rock, 4 Sep. 1967, *A. R. Main s.n.* (PERTH); Sandlewood Rocks, 30 miles [48 km] S of Moorine Rock, 16 Sep. 1964, *N. Marchant* 64232 (PERTH); 12 miles [19.2 km] SE of Merredin on Muntadgin road, 17 Aug. 1964, *N. Marchant* 64116 (PERTH), Merredin Rock, NE of town, 21 Sep. 1970, *N. Marchant* 70320 (PERTH); 18 miles [28.8 km] E of Pithara, 22 July. 1971, *N. Marchant* 71301 (PERTH); Emu Rock, 21 Sep. 1971, *N. Marchant* 71594 (PERTH); 3.1 miles [4.9 km] W of cross roads SW of Lake Cronin, 21 Sep. 1972, *N. Marchant* 72786 (PERTH); 1.5 km S of North Ironcap *c.* 74 km E of Hyden, 13 Sep. 1981, *K Newbey* 8902 (PERTH); 15 miles [24 km] E of Ballidu, 9 Sep. 1946, *R.D. Royce* 1238 (PERTH); Mt Cramphorne E of Muntadgin, 28 July 1963, *R.D. Royce* 7858 (PERTH); Mt Hampton, 7 Aug. 1972, *M. Trudgen s.n.* (PERTH).

Distribution. On inland granite outcrops from Pithara to south-east of Hyden.

Habitat. Drosera rupicola grows in loam soil washes on the aprons of granite outcrops.

Flowering period. July to October.

Conservation status. Drosera rupicola is a common species and is currently not under threat.

Etymology. From the Latin *rufus* – rock and suffix *cola* – dweller, in reference to its preferred granite outcrop habitat.

Affinities. Drosera rupicola differs from all members in sect. *Stolonifera* by having: a turbinate tuber; leafy whorls along the semi-erect lateral stems with transversely-elliptic to depressed-ovate lamina; lamina sides mobile, folding together onto captured insects; and seeds greyish brown, colliculate, reticulate-foveate and variably shaped within the bounds of a cylindrical or rectangular figure.

Notes. All species in sect. *Stolonifera* have small digestive glands centrally positioned close to the lamina

Figure 9. *Drosera rupicola.* A.–plant; B.–cauline leaf lamina; C.–sepal; D.–petal; E.–ovary-styles; F.–style-stigmas, enlarged. Scale bars for all = 1 mm. Drawn by A. Lowrie in 1984 from live material from Bushfire Rock, Western Australia, voucher *A. Lowrie s.n.*, 28 August 1990.

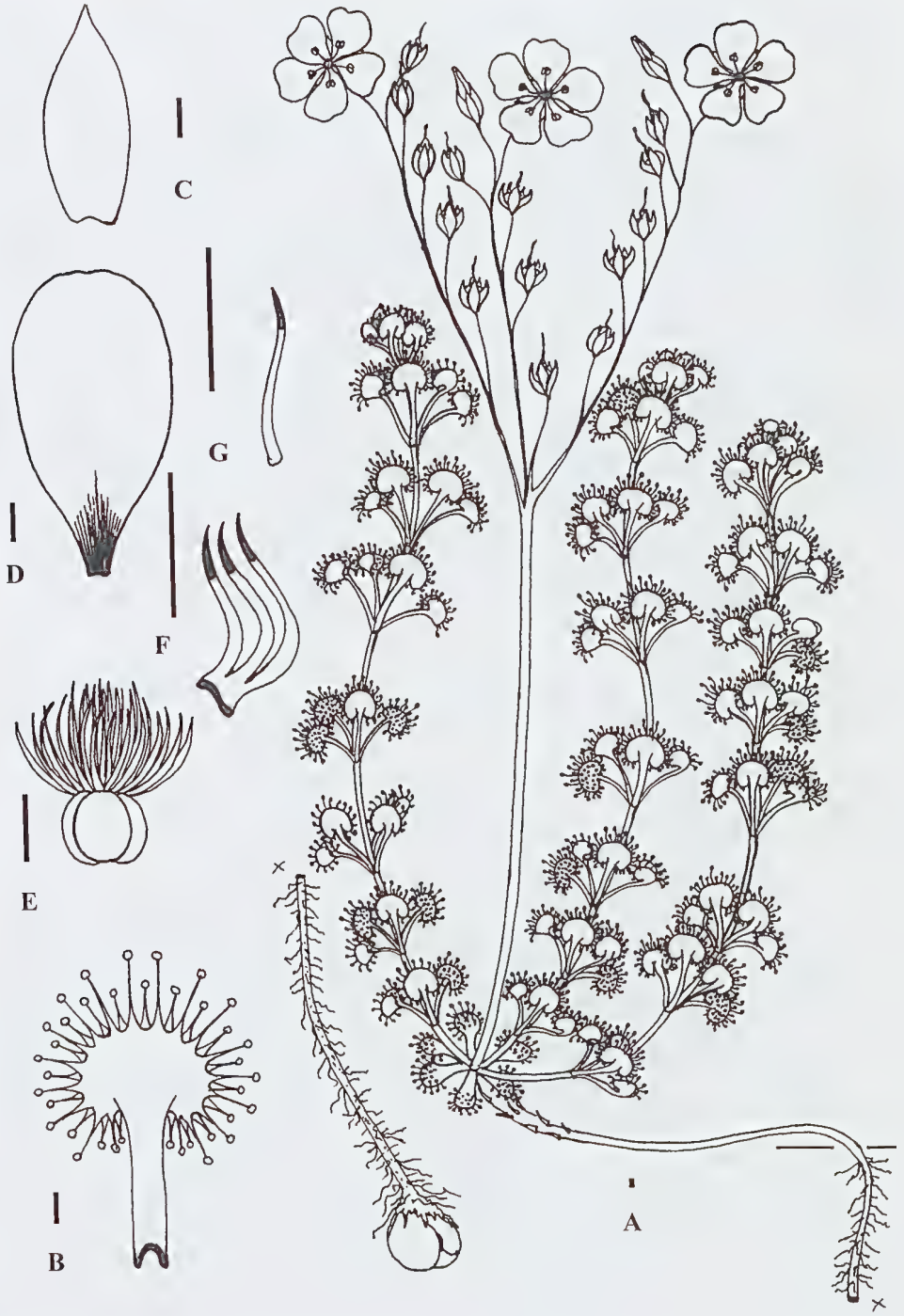

Figure 10. *Drosera stolonifera.* A.–plant; B.–cauline leaf lamina; C.–sepal; D.–petal; E.–ovary-styles; F.–whorled style-stigmas, enlarged; G.–erect style-stigma, enlarged. Scale bars for all = 1 mm. Drawn by A. Lowrie in 2001 from dried and live material from Canning Vale, Western Australia, vouchers (dried material) *R Nash* 736; (live material) *A. Lowrie* 2634.

surface as well as longer retentive glands mostly positioned near and along the margins. Even a single marginal retentive gland has the ability to not only to capture but also hold a struggling prey for a short time.

All retentive glands have mobility. Provided caught prey continues to struggle, it provides the stimulation needed to induce other nearby retentive glands to move towards and adhere their viscid glandular tips onto the prey, thus insuring the prey does not escape. Once the prey is well restrained by a number of retentive glands, they then begin in unison to position the prey closer to the shorter digestion glands covering the adaxial surface of the lamina. It takes about an hour from prey capture to digestion zone placement. Digestion takes but a few days, after which the chitinous exoskeleton of the prey is all that remains, and this is eventually washed away by rain. The retentive glands move back to their positions on the lamina and are ready once more to capture prey.

The time taken for the prey to be digested is directly related to the number of digestion glands in contact with the prey. *Drosera rupicola* is unique within sect. *stolonifera* in as much as it also has mobile laminae. Longitudinally the two halves of a lamina can slowly fold onto the prey in a similar motion to that found in the American Venus Fly Trap *Dionaea muscipula* Ellis ex L. but not as spectacularly fast. This adaptation brings more digestion glands into contact with the prey so complete digestion time is reduced.

The flowers of *Drosera rupicola* are sweetly perfumed. They remain open during the day and night over several weeks or until pollinated.

Drosera stolonifera Endl., *Enumeratio plantarum ...Hügel* 5 (1837). *Type:* "Swan-River. [Western Australia, 3–6 or 16–17 December 1833] (*Hügel*)." (*iso:* W).

Illustrations. L. Diels, *Pflanzenr.* 26: 127, fig. 40 A–C, (1906); R. Erickson, *Plants of Prey in Australia*, plate 4: lower right (1968).

Photographs. A. Lowrie, *Carnivorous Plants of Australia* vol. 1, 127B (1987).

A tuberous-rooted *perennial herb;* foliage green, with 2 or 3 sometimes more semi-erect lateral stems 10–15 cm long arising from the centre of a sparsely leaved basal rosette of 2 leaf types, with another leaf type towards the apex, in whorls of 3 or 4 along the semi-erect stems, all 3 leaf types, petioles, erect stems and scape covered with glass-like minute glands. *Tuber* red, reniform, *c.* 10 mm long, *c.* 15 mm wide, enclosed in a number of brown papery sheaths; stolon vertical (below ground), *c.* 15 cm long, prostrate stolon commonly present, rarely absent (on soil surface), *c.* 1–1.5 mm thick, *c.* 10 cm long. *Lowermost basal leaves* few; petiole flat, 4.5–5 mm long, 1.5–2 to 2.5–3 mm wide; lamina cuneate, 4–5 mm long, 1.5–2 mm wide, adaxial surface in upper parts with insect trapping retentive glands around the margins and smaller glands within; *Upper basal leaves* lamina transversely elliptic, 3–4 mm long, 5.5–7 mm wide, adaxial surface with insect-trapping retentive glands around the margins and smaller glands within. *Cauline leaves* petiole with margins parallel, 5–10 mm long, 1–1.6 mm wide, longitudinally channeled on upper side; lamina reniform, 2.5–3.5 mm long, 4–5.5 mm wide, side margins rolled towards each other to form an open-sided, concave, cone-like arrangement facing upward, almost horizontal, with insect trapping retentive glands around the margins and smaller glands within. *Inflorescence* of a 2–3-branched corymb arising from the basal rosette of leaves and sometimes also minor ones bearing fewer flowers present arising from the leaf axils along the upper parts as well as the apex of the semi-erect leafy stems;

main corymb 15–20 cm long (including scape), 12–20-flowered; pedicels 7–12 mm long. *Sepals* ovate, acute, 3.5–5 mm long, 1.7–3 mm wide, margins entire, glabrous, black dotted. *Petals* white, obovate, apex a little crenate, 7.5–8 mm long, 4–5 mm wide. *Stamens* 5, 3–4 mm long; filaments white; anthers and pollen yellow. *Ovary* green, subglobose, *c.* 1 mm long, *c.* 1.3 mm diam. at anthesis. *Styles* 3, white, *c.* 1.5 mm long, each divided into many long segments, a number arranged in a whorl, flattened and tapering to a point and curved out and upwards from their base, remainder terete, tapering, erect in the centre of the whorl; stigmas simply formed at the apex of each style segment. *Fruit c.* 1.5 mm long, *c.* 2 mm diam., containing *c.* 12 seeds. *Seeds* Black, cupiform, testa cell pattern reticulate, ridges shallow irregular, cell floors shallow ±smooth, 0.5–0.6 mm long, 0.4–0.5 mm wide. (Figures 10: (species illustration); 13: E–F (seed micrographs); 14: M (schematic life-form illustration))

Other specimens examined. WESTERN AUSTRALIA: Claremont, July 1907, *C. Andrews s.n.* (PERTH); between Dunsborough and Cape Naturaliste, 20 Oct. 1982, *K.H. Bechinger s.n.* (PERTH); Pinjarra, Murray River, 23 Sep. 1897, *R. Helms s.n.* (PERTH); Pinjarra, [specimen marked B.], 23 Sep. 1897, *R. Helms s.n.* (PERTH); Burnside Rd, SE of Pinjarra, 21 Sep. 1997, *A. Lowrie* 1876 (MEL, PERTH); NW corner of the junction of Ranford Rd and Nicholson Rd, Canning Vale, 23 Aug. 2001, *A. Lowrie* 2634 (MEL, PERTH); Moores Rd, Pinjarra, 1 Sep. 2001, *A. Lowrie* 2640 (MEL, PERTH); Burnside Rd, SE of Pinjarra, 1 Sep. 2001, *A. Lowrie* 2641 (MEL, PERTH); Canning Vale swamps [urbanised], 15 Oct. 1970, *R. Nash* 736 (PERTH); In Nova Hollandia ad flumen Swan-River, Peninsular, Perth, 31 Aug. 1839, *L. Preiss* 1943 (MEL).

Distribution. Drosera stolonifera populations can still be found in undeveloped swampy locations southwards from Perth to Pinjarra.

Habitat. Drosera stolonifera grows in swamp heathland with paperbark trees *(Melaleuca* sp.). The soil is black, peaty, sandy and water-logged.

Flowering period. September to October. Mass flowering occurs after bushfires.

Conservation status. Drosera stolonifera is a common species and is currently not under threat.

Etymology. From the Latin *stolonis* – stolon and *fero* – to bear, in reference to the fleshy root (stolon) between the tuber and the basal rosette of the foliage.

Affinities. Drosera stolonifera is close to but differs from *D. purpurascens* (whose contrasting characters are given in parenthesis) by having: a life-form 15–25 cm tall (3–10 cm tall); cauline leaf petioles 5–10 mm long (cauline leaf petioles 8–30 mm long); and non-flowering specimens with 3 or more semi-erect leafy stems, without additional solitary cauline leaves at the base (non-flowering specimens often with only 1 erect leafy stem, bearing additional solitary cauline leaves with long petioles at the base.

Notes. Baron Charles von Hügel was in the Swan River region for 23 days between 27 November–19 December 1833, when the young Swan River Colony had only been established for 10 years. A study of his New Holland Journal (Hüegel 1994, translated and edited by Clark) reveals six possible days when he was collecting botanical specimens in suitable swampy areas for the *Drosera stolonifera* type material to have been found. The only recent observation of *D. stolonifera* close to Perth is in the Canning Vale region on swampy flats that retain moisture well into December. From the 3 to the 6 December, Hügel journeyed from Perth to Peninsula [Peninsula, now in suburb of Maylands], Bassendean, Guildford and returned, with a short detour via Helena Valley. Preiss' *D. stolonifera* material, which is similar to Hügel's

type material, was collected from Peninsula, Perth on 31 August 1839. It is possible that Hügel collected his specimens from the same location.

On the 16 December, Hügel journeyed from Perth to swampy areas in the direction of present day Mongers Lake. Swampy areas were common from Perth northwards before urbanization. So Hügel had many opportunities to collect *Drosera stolonifera* from many suitable habitats within and near the town site of Perth on his Swan River visit.

On the 17 December, Hügel traveled from Perth a short distance to an area he called the lagoons, which he described as a marshy area. If it was a fresh water area it too could possibly be a habitat for *Drosera stolonifera.* We will never establish exactly where Hügel collected the type material of *D. stolonifera* but at least the field has been narrowed down to a short list of collection areas on one of six possible days of his visit.

The illustration for *D. stolonifera* page 42, Figure 11. in Marchant (1982) drawn by Philippa Nikulinski has the soil surface line erroneously positioned immediately below the lowermost basal rosette of leaves. This soil line should be drawn just below the tips of the group of prophylls further below. This illustration was drawn from material collected at Bibra Lake, by A. S. George and the species illustrated is a flowering specimen of *D. porrecta,* not *D. stolonifera.*

Two morphs of *Drosera stolonifera* are found in south-west Western Australia, the typical variant from swampland and a hills variant. The swampland variant (which matches the type) grows in peaty sand on winter-wet heath often in association with paperbarks (*Melaleuca preissiana*). The hills variant (Lowrie 1987: photographs 127 A & C) grows in well drained (by runoff) clayey sand mixed with laterite pebbles in Jarrah woodlands and also well drained (by runoff) red loamy soils in Wandoo woodlands. The swampland plant has foliage that remains green throughout its life cycle whereas the hills plant has foliage that starts out green but becomes more reddish with age. The hills morph is generally a more robust individual than the swampland one. Further research using chromosome and DNA studies may establish further grounds to separate these two variants and allow formal recognition of the hills variant.

Drosera stolonifera produces a thick clear jelly-like mass which encloses the first emerging plant bud. This gel remains until the bud bursts into leaf. The gel appears to protect the plant bud from mechanical damage such as that from abrasive sand grains as it grows through the soil. It is possible the gel acts hydraulically to move soil particles ahead away from the fragile plant bud as it grows through the soil. The gel may also protect the juvenile bud from attack by foraging insects or slugs at the soil surface.

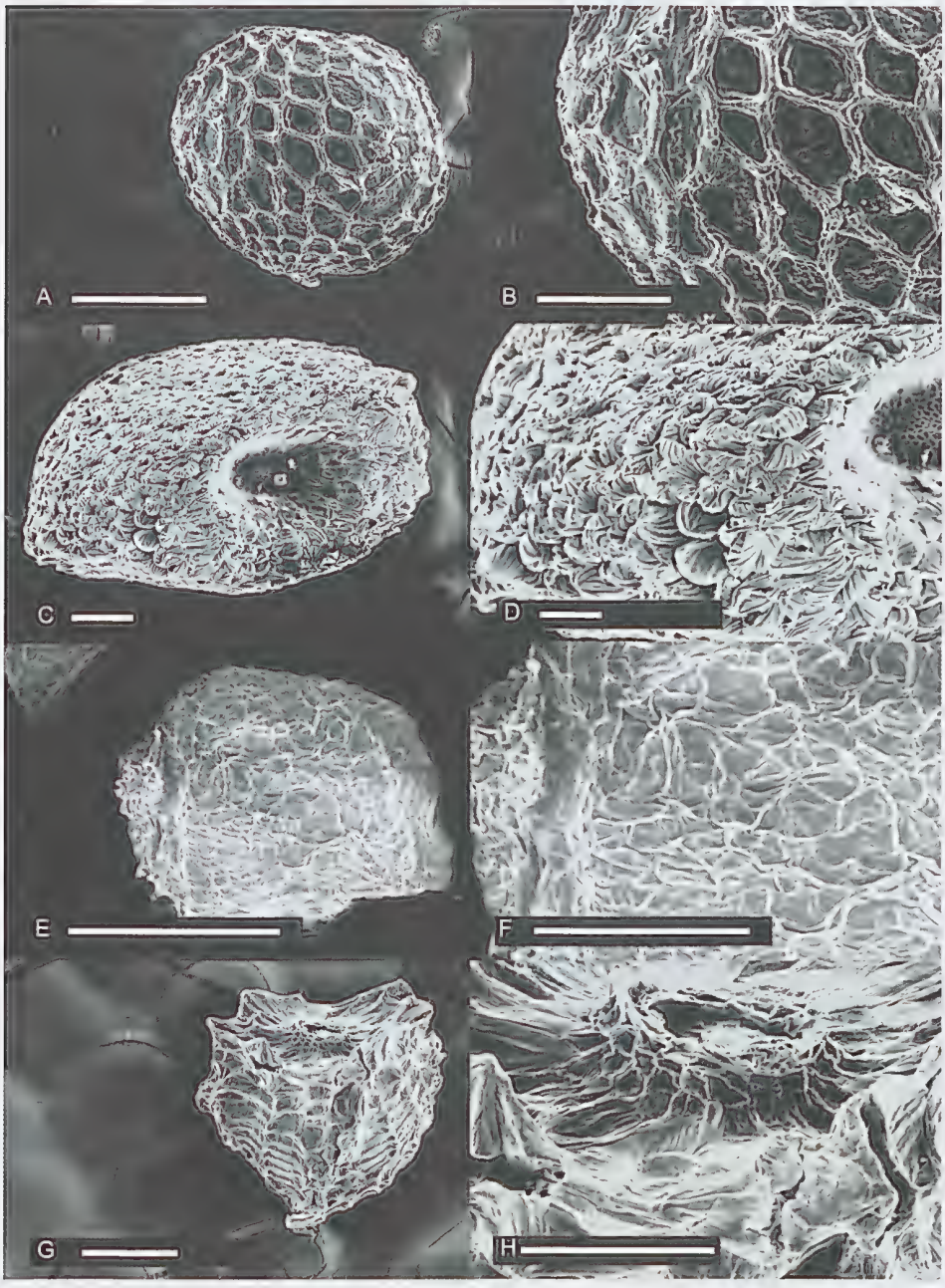

Figure 11: SEM micrographs of *Drosera* seeds and details of testa cell patterns. A–B: *D. fimbriata* (*A. Lowrie* 1583, PERTH). C–D: *D. humilis* (*A. Lowrie* 1543, PERTH). E–F: *D. monticola* (immature seed) (*P. Mann* s.n 8 October 1991, PERTH). G–H: *D. platypoda* (*A. Lowrie* 2573, PERTH). Scales: A,C,E,G = 200mm B,D,F,H = 100µm.

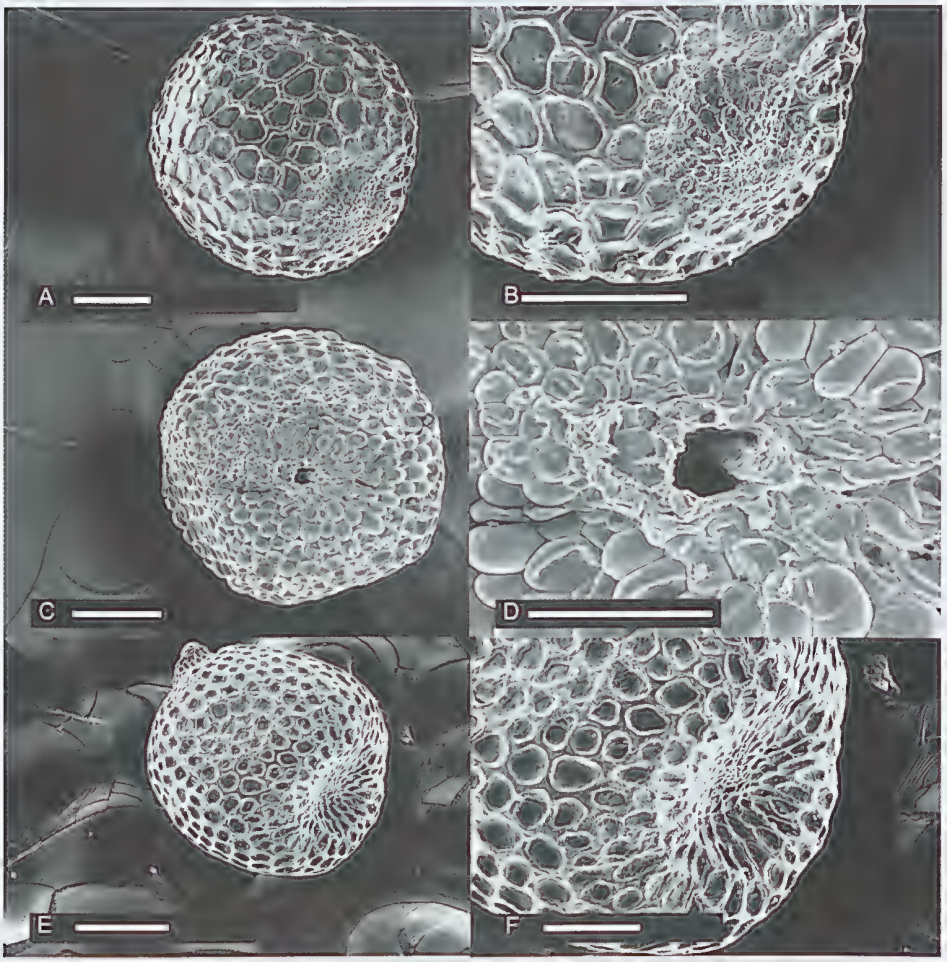

Figure 12. SEM micrographs of *Drosera* seeds and details of testa cell patterns. A–B: *D. porrecta* (*A. Lowrie* 2639., PERTH). C–D: *D. prostrata* (*A. Lowrie* 1813, PERTH). E–F: *D. purpurescens* (*A. Lowrie* 1915, PERTH). Scales: A,C,E = 200mm B,D,F = 100μm.

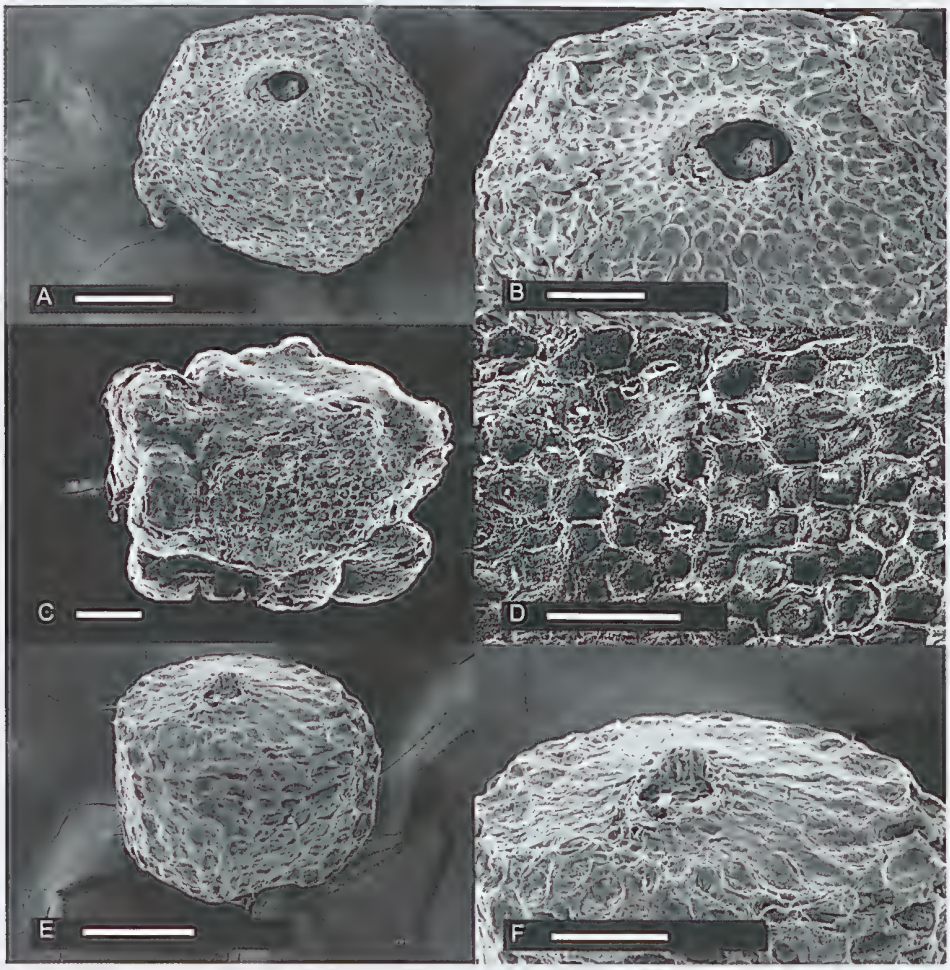

Figure 13. SEM micrographs of *Drosera* seeds and details of testa cell patterns. A–B: *D. ramellosa* (*A. Lowrie* 299, PERTH). C–D: *D. rupicola* (*A. Lowrie* 2093, PERTH). E–F: *D. stolonifera* (*A. Lowrie* 2640, PERTH). Scales: A,C,E = 200mm B,D,F = 100μm.

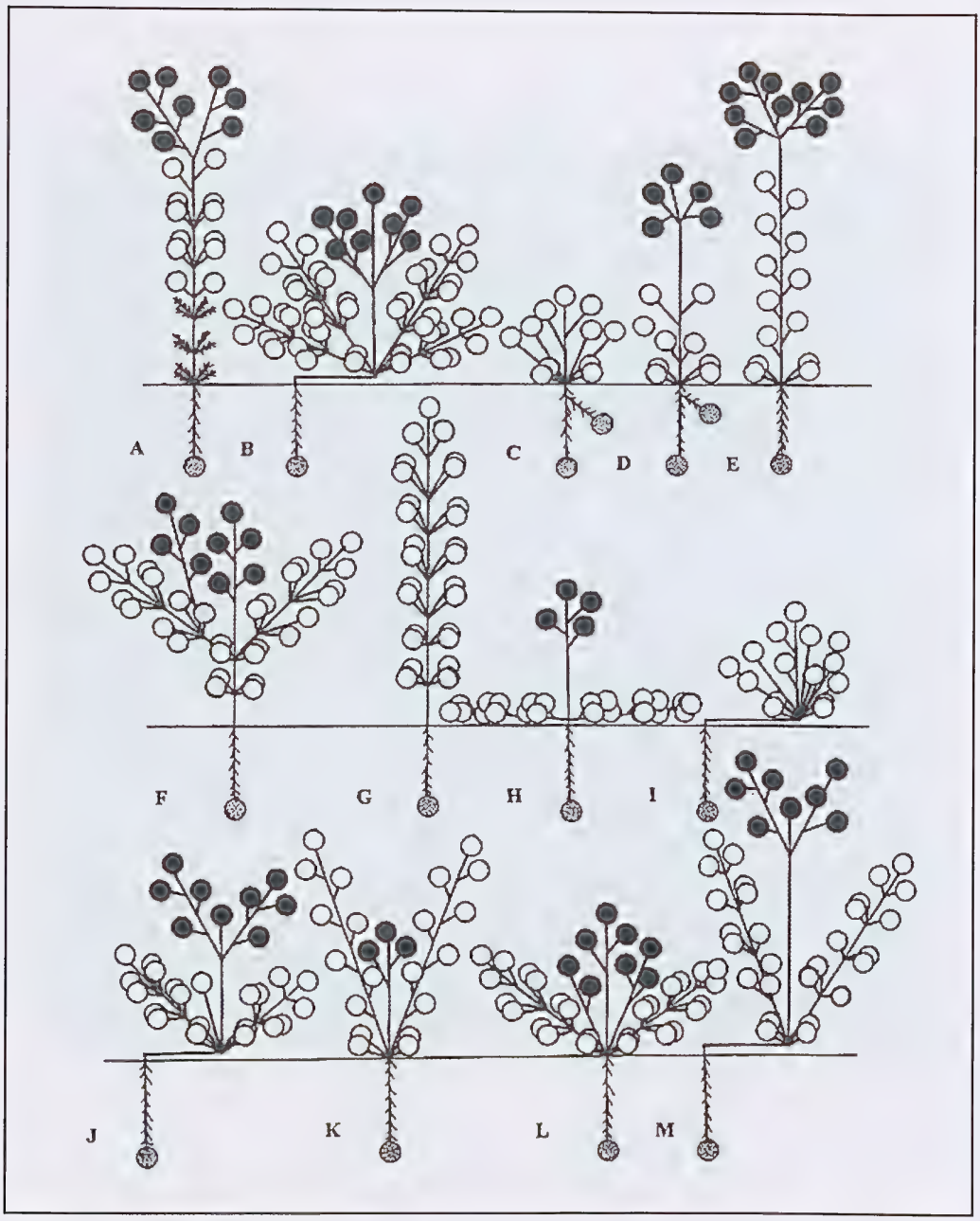

Figure 14: Schematic life-form illustrations of Sect. *Stolonifera.* Stippled circles below the long horizontal lines representing the soil surface are the tubers, whereas open circles above this line represent the leaves and closed circles the flowers. Taxa having horizontal soil surface resting stolons are illustrated with their stolons in parallel just above soil surface line.
A – *D. fimbriata*, B – *D. humilis*, C – *D.monticola (*non-flowering), D – *D. monticola* (flowering), E – *D. platypoda*, F – *D. porrecta* (flowering), G – *D. porrecta* (non-flowering), H – *D. prostrata*, I – *D. purpurascens* (non-flowering), J – *D. purpurascens* (flowering), K – *D. ramellosa*, L – *D. rupicola*, M – *D. stolonifera.* Drawn by Allen Lowrie (2002) in the style of Diels' schematic illustrations (1906: 35).

Acknowledgements

I wish to thank J.H. (Jim) Ross (MEL), Ken Hill Australian Botanical Liaison Officer 1998 (K); Dr R.J. (Bob) Chinnock Australian Botanical Liaison Officer 2000 (K); Dr Ernst Vitek (W), Dr John G. Conran (SEM's Adelaide University); Paul Wilson, Kevin Kenneally, Barbara Rye, Neil Gibson, Greg Keighery, and the staff at the Western Australian Herbarium.

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A rare and endangered new subspecies of *Eucalyptus sargentii* (Myrtaceae) with high potential for revegetation of saline sites from south-western Australia and notes on *E. diminuta* and *E. sargentii* subsp. *fallens*

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Abstract

Nicolle, D. A rare and endangered new subspecies of *Eucalyptus sargentii* (Myrtaceae) with high potential for revegetation of saline sites from south-western Australia and notes on *E. diminuta* and *E. sargentii* subsp. *fallens*. *Nuytsia* 15(3): 395–402 (2005). *Eucalyptus sargentii* subsp. *onesia* Nicolle *subsp. nov.* is described. It is known from less than ten small populations in the central wheatbelt of south-west Western Australia, with all populations occurring on highly saline sites and possibly endangered by increasing salinisation. *E. sargentii* subsp. *onesia* differs from subsp. *sargentii* primarily in the lignotuberous, mallee habit, making it preferable to subsp. *sargentii* for salt reclamation projects, due to its propensity to regenerate following fire or cutting. Extensive field examination, seedling trials and observations of cultivated material have indicated that *E. sargentii* subsp. *fallens* is not specifically distinct from *E. diminuta* and I regard the former as synonymous with the latter. *E. diminuta* is recircumscribed to include populations from Eurardy Station in the north to near Watheroo in the south.

Introduction

Recent field research of *Eucalyptus sargentii* and *E. diminuta*, combined with seedling studies of these species and observations of cultivated material over a number of years (Nicolle 2000), has indicated that the recognition of three taxa (*E. diminuta* and *E. sargentii* with subspp. *sargentii* and *fallens*) is not indicative of the variation within the two species nor of the relationship between the three taxa.

While two subspecies within *E. sargentii* have been recognized (Hill & Johnson 1992), I regard subsp. *fallens* as within the variation seen in *E. diminuta* and recircumscribe *E. diminuta* to include both newly-collected populations and populations previously attributable to *E. sargentii* subsp. *fallens*.

Aside from *E. sargentii* subsp. *fallens*, field surveys have indicated two variants of *E. sargentii*, a non-lignotuberous mallet and a lignotuberous mallee. This latter variant is described as a new subspecies. The new subspecies is numerically rare, but has a high potential for use in the revegetation of saline sites in the wheatbelt of Western Australia.

Taxonomy

E. sargentii and *E. diminuta* are part of *Eucalyptus* ser. *Erectae* subser. *Pedicellatae,* along with *E. astringens, E. aspratilis, E. occidentalis, E. stowardii, E. sporadica* and *E. thamnoides.* The classification and distinguishing features of this subseries within *Eucalyptus* are as follows (modified from Brooker 2000).

E. subg. *Symphyomyrtus* (Schauer) Brooker – cotyledons folded in seeds; buds bi-operculate; seeds with ventral or terminal hilum; seed coat formed from both integuments.

E. sect. *Bisectae* Maiden ex Brooker – Cotyledons bisected; inflorescences axillary.

E. subsect. *Glandulosae* Brooker – Pith of branchlets with glands.

E. ser. *Erectae* Brooker – Mallees or mallets; inflorescences single in axils; operculum long; staminal filaments erect.

E. subser. *Pedicellatae* Blakely – Leaf oil glands not obscuring secondary venation; peduncle flattened or terete; buds held loosely.

This treatment deals only with *E. sargentii* and *E. diminuta.* These two species, along with *E. stowardii*, can be distinguished from the other taxa of the subseries by the terete to angular and parallel-sided peduncles (flattened and distally broadened in the other taxa). *E. stowardii* differs from both *E. diminuta* and *E. sargentii* in the broader, thicker and much glossier adult leaves (to 30 mm wide); the broader, distinctly ribbed buds with a more obtuse operculum and the larger, ribbed fruits (to 15 mm long x 13 mm wide).

Both *E. sargentii* (especially subsp. *onesia*) and *E. diminuta* could be confused with *E. sporadica*, but the latter can be distinguished by the larger (longer and broader) adult leaves, the flattened and distally broadened peduncles and the larger, often less obconical fruit. *E. sporadica* occurs to the south and east of the distribution of *E. sargentii* subsp. *onesia* and *E. diminuta*, but overlaps the distribution of *E. sargentii* subsp. *sargentii*, being ecologically separated (the mallee *E. sporadica* occurring on well-drained sands or gravelly loams, often in minor creek lines; the mallet *E. sargentii* subsp. *sargentii* being restricted to lowland saline sites).

Eucalyptus sargentii Maiden, *Critical Revision of the Genus Eucalyptus* 7: 58 (1924).

Type: Meare Lake, W.A., Sept. 1910, *O.H. Sargent* 707 (*holo:* NSW; *iso:* CANB).

The non-lignotuberous, obligate seeder variant of *E. sargentii* occurs at the type locality of Lake Meares, in the Salt River valley between Quairading and Brookton, W.A.

E. sargentii is distinguished within *E.* subser. *Pedicellatae* by its combination of narrow, linear juvenile leaves, narrow adult leaves, terete peduncles and pedicels and small buds and fruit. *E. sargentii* is distinguished from *E. diminuta* by the narrower, linear seedling leaves, the narrower adult leaves and the smaller buds and fruits.

Tree without a lignotuber (mallet), or *mallee* with a lignotuber. *Bark* rough on trunk(s) up to 4 metres or completely smooth; rough bark ribbony or flaky-fibrous, dark grey to dark grey-brown; smooth bark decorticating in strips, ±glossy, grey to light grey-brown over pink, orange or coppery. *Branchlets* non-pruinose, pith glands present. *Seedling leaves* distinctly petiolate, disjunct from pair 2–4, linear or linear-falcate, 40–80 mm long x 5.5–6.5 mm wide, concolorous to weakly discolorous, non-pruinose, dull, pale green to slightly blue-green. *Adult leaves* disjunct, narrow-lanceolate, petiole 8–12 mm long; lamina 45–80 mm long x 5–10(–14) mm wide, concolorous, slightly glossy and somewhat blue-green at first, maturing glossy, green to dark olive-green; reticulation sparse to moderately sparse; island oil glands moderately dense but not obscuring secondary venation. *Inflorescence* axillary, single, loosely pendulous; peduncles terete, slightly distally broadened, 11–16 mm long; pedicels terete, 3–7 mm long. *Flower buds* 14–24 mm long x 3–5 mm wide, hypanthium smooth, cylindrical to obconical; operculum smooth, cylindrical-horn-shaped, 9–19 mm long. *Flowers* white; stamens erect in bud, all fertile; anthers versatile. *Fruits* smooth, slightly campanulate to obconical, 6–10 mm long x 5–9 mm wide, operculum scar level to slightly ascending, 1–1.5 mm wide; disc descending, *c.* 1 mm wide; valves 4, slightly spreading, at rim level to exserted. *Seed* grey-brown to red-brown, compressed-ovoid, reticulation shallow.

There are two subspecies, both restricted to locally low-lying and highly saline sites, typically fringing salt lakes or in broad saline valley flats.

Notes. E. sargentii is closely related to *E. stowardii* and *E. diminuta* and is most reliably distinguished from both these species by the narrow, linear juvenile leaves compared with the broader, lanceolate juvenile leaves of the latter two species. *E. sargentii* also differs in the smaller adult leaves, buds and fruits in relation to these two species.

The presence of rough bark in both subspecies of *E. sargentii* (as well as in *E. diminuta*) is variable and is apparently dependent on stem diameter and thus plant size and maturity. Mature individuals of subsp. *sargentii* are usually rough-barked on the lower trunk due to their larger stature compared with subsp. *onesia*. However, a completely smooth-barked population of large-sized subsp. *sargentii* is known (*D. Nicolle* 4412 *& M.I.H. Brooker*; 2.7 km E of Koorikin Rd on Kondinin – Corrigin Rd, W.A.).

Two subspecies are recognised differing primarily in regenerative strategy and plant form. Hybrids and intergrades between the subspecies are not known.

Key to the subspecies of *E. sargentii*

1. Obligate seeder; lignotuber absent; tree ..... **subsp. sargentii**
1. Resprouter; lignotuber present; mallee ..... **subsp. onesia**

Eucalyptus sargentii subsp. **sargentii**

Distinguished from subsp. *onesia* by the absence of a lignotuber and the erect tree (mallet) habit.

Mallet, usually erect-stemmed and with a terminal crown, 5 to 12 metres tall. Lignotuber absent. *Bark* persistent and rough on the trunk for one to four metres, flaky-fibrous; smooth above, decorticating in ribbony strips; very rarely smooth-barked throughout.

Specimens examined (north to south): WESTERN AUSTRALIA: Damboring East Rd, S of Pithara, 30° 28'59"S, 116° 44'23"E, 3 Aug. 2002, *D. Nicolle* 4443 & *M. French* (CANB, PERTH); S of Koorda towards Wyalkatchem, 30° 47' 57"S, 117° 19' 15"E, 19 Apr. 1998, *D. Nicolle* 2229 (PERTH); private property 5.8 miles NE of Hines Hill, 25 Nov. 1970, *J. Baker 135* (AD, CANB); Rabbit-proof fence, 2.7 miles E Cunderdin, 12 May 1967, *G. Chippendale* 77 (AD, CANB); 9 km E of Quairading towards Yoting, 4 Oct. 1975, *M.I.H. Brooker* 5000 (AD, CANB, PERTH); 6 km W of Quairading–Corrigin Rd on Beverley East Rd, 23 Aug. 1988, *M.I.H. Brooker* 10040 (AD, CANB, PERTH); salt flats just E of Wave Rock Caravan Park, *c.* 4 km ENE of Hyden, 11 Nov. 1983, *L. Haegi* 2622 & *P.S. Short* (AD, PERTH); 2.7 km E of Koorikin Rd on Kondinin–Corrigin Rd, 32° 27'07"S, 118° 10'07"E, 29 July 2002, *D. Nicolle* 4412 & *M.I.H. Brooker* (CANB, PERTH); 7.9 km W of Pingaring, 21 Oct. 1986, *M.I.H. Brooker* 9478 (AD, CANB, PERTH); edge of *Eucalyptus mimica* subsp. *continens* type population, S of Newdegate, 33° 17' 07"S, 119° 01' 23"E, 22 Nov. 1994, *D. Nicolle* 1115 (PERTH). 0.9 km N on Aylemore Rd, 4 May 1988, *M.I.H. Brooker* 9947 (AD, CANB, PERTH).

Distribution and habitat. Distributed from south of Pithara in the north-west to south-east of Newdegate in the south-east. Its distribution is to the east of subsp. *onesia* and to the south and east of *E. diminuta*. Associated eucalypts include *E. celastroides* subsp. *virella, E. loxophleba* subsp. *loxophleba, E. mimica* subspp. *continens* and *mimica* and *E. spathulata* subsp. *salina.* (Figure 1)

Conservation status. E. sargentii subsp. *sargentii* is widespread and while of scattered occurrence, is locally common and sometimes dominant. While not under short-term threat, the subspecies' distribution at the fringes of salt lakes and otherwise low-lying, saline areas, places this subspecies under longer-term risk of increased salinisation, despite its reputed salt tolerance.

Eucalyptus sargentii subsp. **onesia** Nicolle *subsp. nov.*

Affinis *E. sargentii* subspeciei *sargentii* sed habitu pluricauli ('mallee') et praesentia lignotuberis differt. Affinis *E. diminutae* subspeciei *fallenti* sed foliis adultis angustioribus minoribusque et alabastris fructibusque minoribus differt.

Distinguished from subsp. *sargentii* by the presence of a lignotuber and the spreading, dense mallee habit.

Type: WESTERN AUSTRALIA: Cunderdin to York Rd, 31° 49'41"S, 117° 08'09"E, 19 Apr. 1998, *D. Nicolle* 2238 (*holo:* PERTH 05227038; *iso:* AD, CANB).

Mallee of dense and spreading habit, four to six metres tall. Lignotuber present. *Bark* often smooth throughout, decorticating in ribbony strips; sometimes with some persistent, ribbony rough bark at the base to up to one metre.

Specimens examined (north to south): WESTERN AUSTRALIA: N of Yerecoin towards Piawaning, 30° 54' 09"S, 116° 23' 15"E, 13 Jan. 2001, *D. Nicolle* 3696 & *M. French* (CANB, PERTH); cnr Westlake Rd and Carani East Rd, NE of Calingiri, 30° 59' 51"S, 116° 32' 08"E, 13 Jan. 2001, *D. Nicolle* 3695 & *M. French* (AD, CANB, PERTH); 11.8 km E of rail crossing at Carani, 26 Aug. 1982, *M.I.H. Brooker* 7582, 7583 (AD, CANB, PERTH); 12 km E of Carani Siding, 9 km NW of Nitty Marra Hill, 26 Aug. 1982, *S.D. Hopper* 2478A (PERTH); 7.6 miles E of Carani, 22 Sep. 1989, *B.H. Smith* 1224 (BRI, CANB, HO, PERTH); Mortlock River North crossing on Bolgart East Rd, 3 Sep. 1987, *M.I.H. Brooker* 9750 (CANB, PERTH); Mortlock River E branch, 2 km N of Great Eastern Highway on Hopkins Rd, 9.5 km from Meckering towards Cunderdin,

31°36'31"S, 117°06'13"E, 24 Mar. 2001, *M. French* 1280 (AD, PERTH); Near Meckering on Great Eastern Highway, 31°39'22"S, 116°59'11"E, 30 Sep. 2000, *D. Nicolle* 3456 & *M. French* (CANB, PERTH); 3.3 km SW of Meckering, 4 May 1987, *M.I.H. Brooker* 9587 (AD, CANB, PERTH).

Distribution and habitat. Restricted to seven known populations in the central wheatbelt of Western Australia. These populations occur in an approximate north-south line from Piawaning south-south-east to between York and Cunderdin, over a linear range of approximately 120 km. This is to the west and disjunct from *E. sargentii* subsp. *sargentii*. All seven populations occur as pure stands in depressions or broad drainage lines that vary from slightly to highly saline. Abutting vegetation on slightly higher and less saline sites is woodland of *E. loxophleba* subsp. *loxophleba, E. myriadena* or *E. wandoo* subsp. *wandoo*. (Figure 1)

Conservation status. All the known populations of this taxon occur on road or rail verges or on adjacent private farmland. The smallest population (north of Yerecoin) consists of only one or two apparent individuals while several populations consist of 20 to 50 apparent individuals. Given the small population sizes, the land tenure on which they occur, and the threat to these populations from salinity and destruction from farm or roadside clearing, the taxon requires further survey to determine its conservation status and whether it should be included on Western Australia's Schedule of Declared Rare Flora. Current status – Conservation Codes for Western Australian Flora: Priority One.

Etymology. From the Greek *onesis* (advantage; use) referring to the potential this subspecies has for reclamation of saline sites, particularly in the central wheatbelt of Western Australia.

Notes. This taxon appears to have been previously unrecognized because historically, accurate assessment of habit and lignotuber variation in the species has been overlooked, and because herbarium specimens of subsp. *onesia* are indistinguishable from subsp. *sargentii*.

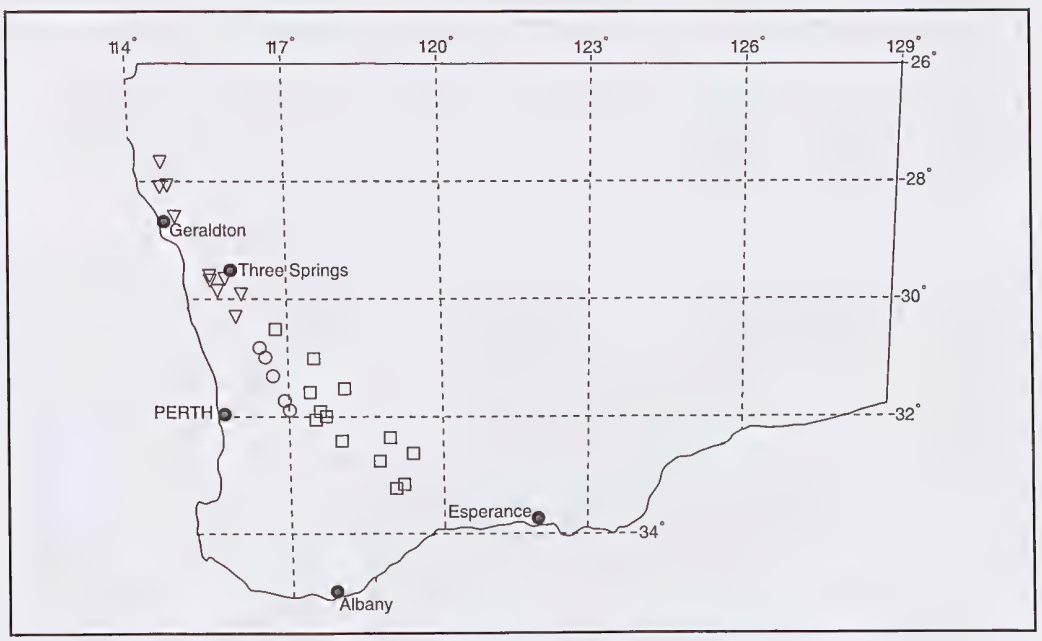

Figure 1. Map of Western Australia below 26°S, showing the distribution of: *Eucalyptus diminuta* ∇, *Eucalyptus sargentii* subsp. *sargentii* □ and *Eucalyptus sargentii* subsp. *onesia* ○.

Eucalyptus diminuta Brooker & Hopper, *Nuytsia* 14(3): 358 (2002).

Type: Yuna Rd, 28° 42' S, 114° 40' E, W.A., 4 Nov. 1985, *M.I.H. Brooker* 9061 (*holo:* PERTH 1066846; *iso:* CANB, NSW).

Eucalyptus sargentii subsp. *fallens* K.D. Hill & L.A.S. Johnson, *Telopea* 4(4): 575 (1992).

Type: 3 km N of Binnu on Highway 1, W.A., 21 Nov. 1986, *K.D. Hill* 2565, *L.A.S. Johnson, D.F. Blaxell & M.I.H. Brooker* (*holo:* NSW; *iso:* PERTH 05966035).

E. diminuta is distinguished within *E.* subser. *Pedicellatae* by its combination of lignotuberous, mallee habit; lanceolate to ovate juvenile leaves; small, lanceolate adult leaves and terete to slightly distally flattened peduncles and pedicels.

E. diminuta is distinguished from *E. sargentii* by the broader, ovate to lanceolate seedling leaves, the broader adult leaves and the larger buds and fruits.

Mallee, 3–6 metres tall; lignotuber present. *Bark* smooth throughout, decorticating in strips, ±glossy, grey to grey-brown over cream to reddish or orange-tan (coppery); rarely with some ribbony or flaky rough bark near the base of the stems. *Branchlets* non-pruinose, pith glands present. *Seedling leaves* distinctly petiolate, disjunct from pair 2–4, ovate to broad-lanceolate, later becoming lanceolate, 40–70 mm long x 14–20 mm wide, concolorous to weakly discolorous, non-pruinose, dull to very slightly glossy, green to blue-green. *Adult leaves* disjunct, lanceolate, petiole 12–16 mm long; lamina 55–115 mm long x (8–) 10–20 mm wide, concolorous, glossy, slightly blue-green at first, maturing slightly blue-green to olive green; reticulation sparse to scattered; island oil glands moderately dense but not obscuring secondary venation. *Inflorescence* axillary, single, loosely pendulous; peduncles terete to moderately flattened, slightly to moderately distally broadened, 14–26 mm long; pedicels terete, 4–18 mm long. *Flower buds* 20–26 mm long x 4–5 mm wide, hypanthium smooth to weakly striate, cylindrical; operculum smooth to weakly striate, cylindrical to horn-shaped, 12–18 mm long. *Flowers* white; stamens erect in bud, all fertile; anthers versatile. *Fruits* smooth to weakly striate, campanulate, 11–13 mm long x 9–12 mm wide, operculum scar level to slightly ascending, 1–2 mm wide; disc descending, *c.* 1 mm wide; valves 4, slightly spreading, at rim level to exserted. *Seed* grey-brown, compressed-ovoid, reticulation shallow.

Specimens examined (north to south): WESTERN AUSTRALIA: Bungabandi Creek, 9 Oct. 1986, *M.I.H. Brooker* 9471, 9472 (AD, CANB, PERTH); W of Eurardy, 24 Aug. 1969, *D.J. Carr & S.G.M. Carr* 962, 963 (AD, CANB); ca. 3 km N of Binnu on NW Coastal Hwy, 28° 00' 38"S, 114° 40' 24"E, 27 Nov. 1994, *D. Nicolle* 1168 (PERTH); 3 km N of Binnu, 11 June 1985, *M.I.H. Brooker* 9036 (AD, CANB, PERTH); S side of salt lake 3 km N of Binnu, 4 Nov. 1985, *M.I.H. Brooker* 9063 (AD, CANB, PERTH); pass NE of Geraldton on Yuna Rd, 11 June 1985, *M.I.H. Brooker* 9038 (AD, CANB, PERTH); Yuna Rd, 28° 42' 06"S, 114° 41' 42"E, 12 Dec. 1992, *D. Nicolle* 271 (PERTH); 7.7 km from Geraldton – Northampton Rd on Yuna Rd, 30 Oct. 1984, *M.I.H. Brooker* 8721 (AD, CANB, PERTH); 8 km NE of Geraldton on Nabawa Rd, 28 May 1983, *D.F. Blaxell* 1995 (AD, CANB, MEL, NSW, PERTH); Mindaloo Beacon, 29° 33' 23"S, 115° 27' 06"E, 29 Oct. 2000, *D. Nicolle* 3544 & *M. French* (PERTH); W side of Mindaloo Beacon Hill, 21 Apr. 1988, *M.I.H. Brooker* 9938 (AD, CANB, PERTH); 13.1 km SW of Three Springs towards Eneabba, 21 Nov. 1986, *M.I.H. Brooker* 9554 (AD, CANB, PERTH); SW of Three Springs on Eneabba Rd, 29° 35' 45"S, 115° 41' 02"E, 4 Feb. 2001, *D. Nicolle* 3767 & *M. French* (CANB, PERTH); SW of Three Springs, 1 Nov. 1984, *M.I.H. Brooker* 8735, 8736 (AD, CANB, PERTH); 2.1 km from Skipper Rd on Bunny Rd, 29° 36' 20"S, 115° 25' 53"E, 4 Feb. 2001, *D. Nicolle* 3770 & *M. French* (AD, CANB, PERTH); Mingenew – Eneabba Rd, 28 May

1983, *D.F. Blaxell* 1995 (AD, CANB, NSW, PERTH); 34.5 km from Three Springs on Eneabba–Mingenew Rd, 24 Oct. 1980, *M.D. Crisp* 7092 (AD, CANB, MEL, NSW, PERTH); 1.0 km from South Waddi Rd on Old Watheroo Rd, 29° 55' 17"S, 116° 05' 58"E, 4 Feb. 2001, *D. Nicolle* 3764 & *M. French* (AD, CANB, PERTH); N of Watheroo, 30° 16' 20"S, 116° 02' 23"E, 13 Jan. 2001, *D. Nicolle* 3697 & *M. French* (CANB, PERTH).

Distribution and habitat. Distributed from Eurardy Station (between Geraldton and Shark Bay) southwards to near Watheroo. This distribution is more extensive than that described for *E. diminuta* by Brooker and Hopper (2002) because of the inclusion of populations previously attributed to *E. sargentii* subsp. *fallens* and other, recently recognised southerly populations. *E. diminuta* occupies a range of habitats including well-drained upland sites on decomposed granite (e.g. the Moresby Range and near Coorow, Three Springs and Watheroo), poorly drained fresh-water seeps in sandy soils on upland sites (e.g. around Mindaloo Beacon) and low-lying drainage areas subject to salinisation (e.g. in the Binnu area). *E. diminuta* has a very scattered distribution, but can be locally common. Associated eucalypts include *E. accedens, E. blaxellii, E. eudesmioides – E. gittinsii* subsp. *illucida* intergrades, *E. horistes* (syn. *E. hypochlamydea*), *E. loxophleba, E. petraea* and *E. todtiana*. (Figure 1)

Conservation status. Using the Conservation Codes for Western Australian Flora, *E. sargentii* subsp. *fallens* is currently classified as Priority One and *E. diminuta* as Priority Three. With the synonymisation of these two taxa and the recent collections extending the range southerly, the conservation code applied to *E. diminuta* is amended to Priority Four: rare but not currently threatened.

Notes. There appear to be no consistent morphological differences between populations that have previously been attributed to either *E. diminuta* and *E. sargentii* subsp. *fallens*, including the types of both taxa. Brooker and Hopper (2002) distinguish *E. sargentii* subsp. *fallens* from their new species *E. diminuta* by the 'consistently smooth bark, slightly ribbed obtuse opercula, and occurrence on hills and breakaways'. Many individuals and whole populations of individuals previously attributed to *E. sargentii* subsp. *fallens* are smooth-barked, including those at the type population. Brooker and Hopper (2002), in their key including *E. sargentii* subsp. *fallens*, and Hill and Johnson (1992), both correctly state that rough bark is present at the base of larger individuals only. As for the opercula character differences, as stated below, a full range of variation exists that exhibits no strong correlation to habitat or distribution. The last difference Brooker and Hopper (2002) mention is not a morphological difference, and as mentioned above, arguably intermediate habitats are known for some populations. I cannot, therefore, reasonably maintain these two taxa as distinct entities, at least as previously circumscribed, and have synonymised *E. sargentii* subsp. *fallens* under *E. diminuta*.

There is some degree of population-based variation in the adult morphology of *E. diminuta*. Populations from the Moresby Range (including the type population) tend to be coarsest in buds and fruits and with more obtuse and striate opercula, while populations in the vicinity of Mindaloo Beacon tend to be less coarse and with more apiculate, smooth opercula. All other populations fit between these extremes. Despite the variability in adult morphology in *E. diminuta*, there appears to be no consistent correlation between morphology and habitat or distribution. In any case, this variability is considered relatively minor and barely worthy of taxonomic recognition, even if an ecological or geographical association with the variation is discovered. Seedling morphology throughout all the populations of *E. diminuta* grown (Binnu, Mindaloo Beacon, Moresby Range and Watheroo) is both very consistent and distinctive from that of *E. sargentii*.

The adult morphology of *E. diminuta* suggests is it most closely related to *E. sargentii*, while the seedling morphology places it closer to *E. stowardii*. *E. stowardii* is distinguished from *E. diminuta* (and

E. sargentii) by the broader and thicker, highly glossy adult leaves, the broader buds with more obtuse, ribbed opercula and the larger, slightly ribbed fruit. *E. stowardii* is restricted to well-drained upland sites on decomposed granite, with a widespread but very scattered distribution from near Morawa and Mt Gibson south to near Sandford Rock, north-east of Westonia.

Acknowledgments

I am indebted to Malcolm French for sharing his knowledge and accompaniment on field trips to assess variation in *E. diminuta* and *E. sargentii*.

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Re-assessment of the saline-dwelling *Eucalyptus spathulata* complex (Myrtaceae) from southern Western Australia

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Abstract

Nicolle, D. and Brooker, M.I.H. Re-assessment of the saline-dwelling *Eucalyptus spathulata* complex (Myrtaceae) from southern Western Australia. *Nuytsia* 15(3) : 403–429 (2005). The circumscription of taxa within the *Eucalyptus spathulata* complex is revised. The status of *E. vegrandis* is resolved and the new species *E. orthostemon* Nicolle & Brooker is described to accommodate populations of mallees previously and erroneously referred to *E. vegrandis*. The new taxon *E. vegrandis* subsp. *recondita* Nicolle & Brooker is described to accommodate coarse, relatively broad-leaved mallees in the Stirling Range area, previously referred under the manuscript name *E.* 'recondita'. *E. suggrandis* is re-circumscribed, with subsp. *alipes* (as to the type – the mallet/obligate seeder variant) raised to specific status as *E. alipes* (L. Johnson & K. Hill) Nicolle & Brooker. *E. mimica* is recircumscribed as an obligate seeder (mallet) species and *E. suggrandis* subsp. *promiscua* Nicolle and Brooker described from the Lake Grace – Pingrup area, previously being confused with both *E. mimica* and *E. suggrandis*. The new subspecies, *E. spathulata* subsp. *salina* Nicolle & Brooker, is described from mallets restricted to the Salt River drainage system of the northern part of the southern wheatbelt. *E. cernua* is recircumscribed as an obligate seeder (mallet) species with resprouter (mallee) populations, previously included under *E. cernua*, published as *E. proxima* Nicolle & Brooker. The manuscript name *E.* 'verruculosa' is considered to be *E. suggrandis* subsp. *suggrandis*, as to the proposed type. A key and distribution maps for the *E. spathulata* complex are provided. The conservation status for some taxa in the complex is critical, owing to their natural saline habitat and the revised (and in many cases much reduced) geographical distribution of taxa as delimited here. One taxon is already included on Western Australia's Schedule of Declared Rare Flora (*E. steedmanii*) and two others are considered as high priority for further survey and nomination to the Schedule (*E. spathulata* subsp. *salina* and *E. mimica* subsp. *continens*).

Introduction

This paper is presented in part to recognise the heterogeneous nature of the specimens attributed to *E. vegrandis* as proposed in the protologue (Hill and Johnson 1992) and to erect the anomalous part of this taxon as a widespread unnamed species, *E. orthostemon*. The paper also aims to clearly describe and delineate the species closely related to *E. vegrandis* (*E.* ser. *Clinatae* Brooker), and those of the *E. spathulata* complex (*E.* supraspecies *Angustae* Brooker) in which we describe three new taxa.

The *E. spathulata* complex is distinguished from related taxa in *E.* subser. *Abundae* Brooker mainly

by the shorter operculum that is often not acute, as opposed to longer and very acute operculum in the related *E. eremophila* complex (*E.* supraspecies *Longae* Brooker).

We have recently recognised and studied two important characters useful for taxon delimitation within the complex. These are:

a) staminal arrangement (erect or inflexed), and

b) growth form (lignotuber present (mallee) or absent (mallet)).

We have used extensive field and herbarium research combined with long-term cultivation trials by one of us (DN) to assess the *E. spathulata* complex for both these characters, as well as used other morphological characteristics considered to be either less useful or more variable. We have re-circumcribed all taxa in the complex and in *E.* ser. *Clinatae*.

The *E. spathulata* complex, as delimited here, consists of part of *E.* ser. *Erectae* Brooker subser. *Abundae* Brooker (the short-operculate taxa of this subseries) as well as the superficially similar but less related *E.* ser. *Clinatae*. Thus the complex as described here is not a natural group, but the conglomeration of two natural groupings, viz. the *E. spathulata* complex *sens. strict. (E. spathulata, E. orthostemon, E. alipes, E. mimica, E. steedmanii* and *E. suggrandis*) and the *E.* ser. *Clinatae* (*E. vegrandis, E. proxima, E. cernua* and *E. vesiculosa*).

Classification of the *Eucalyptus spathulata* complex

E. ser. *Erectae* Brooker
- *E.* subser. *Abundae* Brooker
  - *E.* supraspecies *Angustae* Brooker
    - *E. spathulata* Hook.
      - subsp. *spathulata*
      - subsp. *salina* Nicolle & Brooker
    - *E. orthostemon* Nicolle & Brooker
    - *E. suggrandis* L. Johnson & K. Hill
      - subsp. *suggrandis*
      - subsp. *promiscua* Nicolle & Brooker
    - *E. alipes* (L. Johnson & K. Hill) Nicolle & Brooker
    - *E. mimica* Brooker & Hopper
      - subsp. *mimica*
      - subsp. *continens* Brooker & Hopper
    - *E. steedmanii* C. Gardner

E. ser. *Clinatae* Brooker
- *E. vegrandis* L. Johnson & K. Hill
  - subsp. *vegrandis*
  - subsp. *recondita* Nicolle & Brooker
- *E. proxima* Nicolle & Brooker
- *E. cernua* Brooker & Hopper
- *E. vesiculosa* Brooker & Hopper

The following taxa are here excluded from the *E. spathulata* complex: *E.* subser. *Annulatae* L.A.S. Johnson & K. Hill ex Brooker (3 taxa); *E.* subser. *Pedicellatae* Blakely (c. 10 taxa); *E.* supraspecies *Latae* Brooker (4 taxa); *E.* supraspecies *Longae* Brooker (4 or 5 taxa).

The adult leaves of *E.* ser. *Erectae* subser. *Abundae* (Figure 1A) have numerous densely spaced oil glands obscuring the secondary venation, in contrast to the adult leaves of *E.* ser. *Erectae* subser. *Pedicellatae* (Figure 1B), which are much less densely glandular enabling the secondary and tertiary venation to be clearly seen in transmitted light (Brooker 2002). The adult leaves of *E.* ser. *Clinatae* (Figure 1C), like those of *E.* ser. *Erectae* subser. *Abundae,* are densely glandular, although usually the secondary (but not tertiary) venation can be clearly seen.

All species in *E.* supraspecies *Angustae* except *E. suggrandis* and *E. steedmanii* usually occupy subsaline to saline depressions and drainage lines, with some taxa in the complex restricted to such sites (e.g. *E. spathulata, E. mimica* and *E. alipes*). Conversely, all members of *E.* ser. *Clinatae* occupy non-saline habitats, although often these are on poorly-drained clay soils in up-land sites.

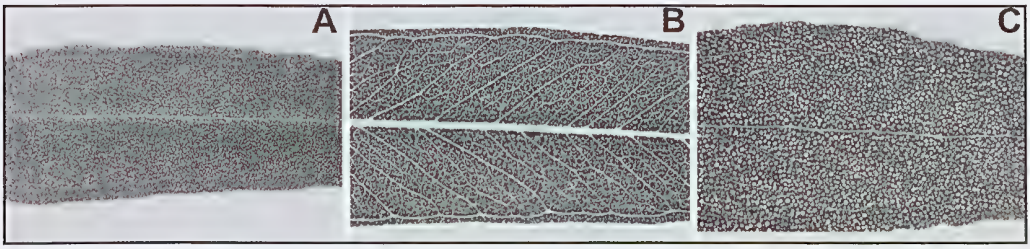

Figure 1. Leaf venation and oil gland pattern typical of: A – *E.* ser. *Erectae* subser. *Abundae* (*E. eremophila*; Burra Rock); B – *E.* ser. *Erectae* subser. *Pedicellatae* (*E. astringens* subsp. *redacta*; *Brooker* 12918); C – *E.* ser. *Clinatae* (*E. vesiculosa*; *Brooker* 9910).

Key to species and subspecies the *E. spathulata* complex[1]

1. Staminal filaments erect
 2. Mallet; lignotuber absent
  3. Buds and fruits terete, 3 and/or 7-flowered
   4. Adult leaves distinctly metallic bluish; inflorescence 7-flowered; fruit small (4–7 mm long x 4–6 mm wide) ..... **1a. E. spathulata subsp. spathulata**
   4. Adult leaves green; inflorescence 3- or 7-flowered; fruit large (6–8 mm long x 6–6.5 mm wide) ..... **1b. E. spathulata subsp. salina**
  3. Buds and fruits angled to square in transverse section, 3-flowered
   5. Fruit small (11–17 mm long x 7–11 mm wide)
    6. Buds and fruits not square, smooth or 2-angled from pedicel ..... **3. E. alipes**
    6. Buds and fruits square and strongly 3- or 4-ribbed
     7. Sepaline structure non-operculate, as four distinct sepals, often shedding before inner operculum ..... **4a. E. mimica subsp. mimica**
     7. Sepaline structure operculate and persisting to flowering ..... **4b. E. mimica subsp. continens**
   5. Fruit large (18–23 mm long x 13–16 mm wide) ..... **5. E. steedmanii**
 2. Mallee; lignotuber present
  8. Pedicel well-defined in fruit, ±terete; fruit smooth; leaves 2 to 7 mm wide ..... **2. E. orthostemon**
  8. Pedicel poorly defined and tapering to fruit, ±flattened; fruit 2-angled near base; leaves 5 to 18 mm wide
   9. Outer operculum shed early and cleanly, sepals not formed ..... **6a. E. suggrandis subsp. suggrandis**
   9. Outer operculate structure either forming persistent sepals or decorticating in scales ..... **6b. E. suggrandis subsp. promiscua**
1. Staminal filaments inflexed
 10. Mallee; lignotuber present
  11. Peduncles erect, flowers cream
   12. Adult leaves narrow (3–13 mm wide) ..... **7a. E. vegrandis subsp. vegrandis**
   12. Adult leaves broad (13–25 mm wide) ..... **7b. E. vegrandis subsp. recondita**
  11. Peduncles rigidly down turned; flowers often red, rarely creamy-yellow ..... **8. E. proxima**
 10. Mallet; lignotuber absent
  13. Adult leaves broadly elliptical to orbicular; operculum prominently warty ..... **10. E. vesiculosa**
  13. Adult leaves broad-lanceolate; operculum smooth ..... **9. E. cernua**

[1] NB. We interpret the sepaline whorl in the flower bud as being either operculate or consisting of distinct sepals or scales.

Taxonomy

1. Eucalyptus spathulata Hook. *Icon. Pl.* 7: t. 611 (1844).

Type: Swan River Colony, *J. Drummond*, Supp. coll. No. 20 (*holo*: K).

Distinguished within the complex by its combination of non-lignotuberous, mallet habit; the narrow, linear adult leaves, the cream, erect staminal filaments and the small, more or less terete buds and fruits.

Mallet (obligate seeder), 6 to 12 m tall. *Lignotuber* absent. *Seedling leaves* shortly petiolate, linear. *Adult leaves* linear, glossy, metallic blue-green to green; lamina 45–75 mm long x 2.5–7 mm wide. *Inflorescences* (3–) 7-flowered; peduncles 4–8 mm long; pedicels terete, 2–6 mm long. *Flower buds* held erect, 9–15 mm long x 2.5–4.5 mm wide; operculum often narrower than hypanthium at join, cylindrical, ±smooth; *flowers* cream; stamens erect. *Fruit* held erect, distinct from pedicel, obconical to cupular-hemispherical, 4–8 mm long x 4–6 mm wide, smooth; valves 3.

The type of *E. spathulata* has presented problems in the application of the name. The type (held at K) has erect staminal filaments, linear leaves and relatively small buds and fruits for the complex. These features and the unhelpful type locality indicate the type could be either the fine-leaved mallet taxon (*E. spathulata* subsp. *spathulata*) or the mallee taxon (*E. orthostemon*), which have overlapping distributions south-east of Perth. The size of the leaves, buds and fruits in the type is in the common range for that of fine-leaved mallet taxon and at the fine-end of the range for the mallee taxon. Both the notes on the type specimen and the protologue give no indication of the habit of the individual or species respectively. Given that the type specimens are (morphologically) more likely to be that of the mallet taxon and the fact that the mallet taxon has been widespread and common in cultivation for many years while the mallee taxon is virtually unknown in cultivation, we have decided that it is reasonable to assume that *E. spathulata* refers to the fine-leaved mallet taxon as recognised here.

Two subspecies can be recognised, geographically separated (Figure 2A) and restricted to different drainage systems, differing in adult leaf, bud and fruit morphology.

1a. Eucalyptus spathulata Hook. subsp. **spathulata**

Distinguished from subsp. *salina* by the generally narrower (2.5–5 mm wide), bluish adult leaves, consistently 7-flowered inflorescences and smaller fruits (4–7 mm long x 4–6 mm wide). (Figure 2B)

Selected specimens examined: WESTERN AUSTRALIA: Dumbleyung, 17 June 1920, *C.A. Gardner* 15 (PERTH); Pingrup, 32 mls S of Lake Grace, 21 Sep. 1933, *W.E. Blackall* 3038 (PERTH); 2 mls E of Ongerup, 3 Aug. 1957, *J.W. Green* 1465 (PERTH); Ongerup townsite, May 1969, *B. Rockel* A22 (PERTH); 24 km from Katanning along road to Nyabing, 16 Jan. 1979, *M.D. Crisp* 5195 (CANB, MO, NSW, PERTH); Lake Cobham, Magenta Rd, 3 July 1984, *P. van der Moezel* 393 (PERTH); On Pingrup–Lake Grace Rd, 23 km S of its junction with Lake-Grace–Newdegate Rd, 23 km S of Lake Grace, 14 Oct. 1986, *S.D. Hopper* 5694 (PERTH); 1 km E of Ongerup on main Hwy, 21 Oct. 1992, *P.J. White* 370 (PERTH); Wagin, N edge Flagstaff Nature Reserve, 2.4 km E of Flagstaff Rd, 3 Nov. 1993, *P.J. White* 378 (CANB, PERTH); 3 km W of Lake Grace on road to Kukerin–W side of Lake Grace, 3 Nov. 1993, *P.J. White* 380 (CANB, K, PERTH); 3.7 km S of 129 road along Wishbone South Rd, 8 Nov. 1993, *P.J. White* 370 (CANB, PERTH); 31 km on Ongerup–Pingrup Rd going S, 18 Oct. 1994, *L. Sweedman* 3468 (PERTH); Lake Magenta Nature Reserve, May 1995, *W. O'Sullivan* 198 (PERTH); S of Ongerup on bend in road between golf club and the town, 33° 58' 12"S,

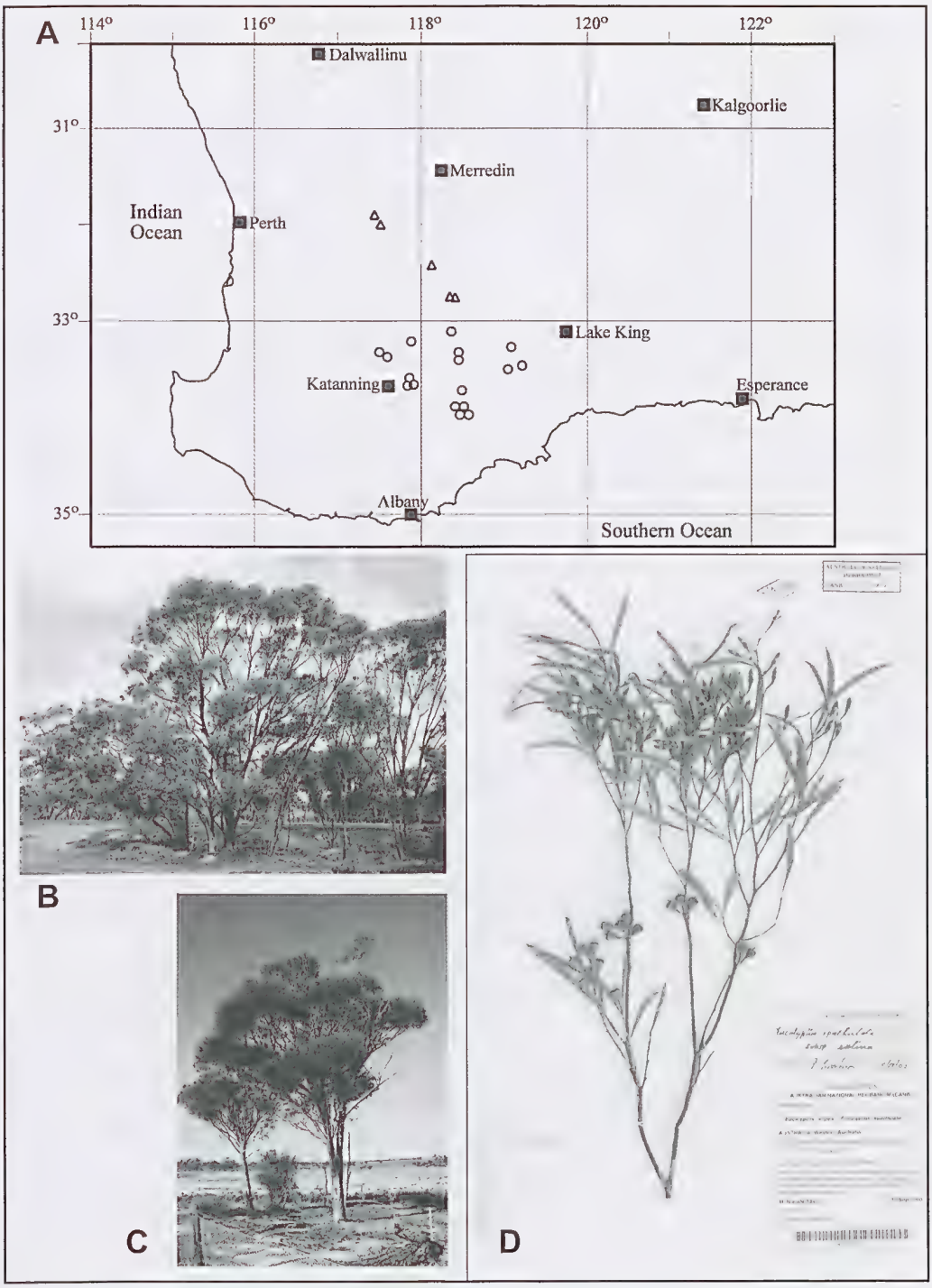

Figure 2. A – Distribution of *E. spathulata* subsp. *spathulata* ○ and subsp. *salina* △ in Western Australia;
B – Habit of *E. spathulata* subsp. *spathulata* (Katanning–Nyabing Rd, 33° 41' 10"S, 117° 45' 19"E);
C – Habit of *E. spathulata* subsp. *salina* (Mt Stirling Road, NE of Quairading, 31° 53' 42"S, 117° 30' 20"E);
D – Isotype of *E. spathulata* subsp. *salina* (*D. Nicolle* 3435 & *M. French*).

118° 30' 03"E, 5 May 1999, *A. Slee* 4138 (CANB, PERTH); Parsons Rd, E of Lee Rd, S of Newdegate, 33° 10' 10"S, 119° 05' 36"E, 30 July 2002, *D. Nicolle* 4420, 4421 & *I. Brooker* (CANB, PERTH); Katanning–Nyabing Rd, 33° 41' 10"S, 117° 45' 19"E, 30 July 2002, *D. Nicolle* 4429 & *I. Brooker* (CANB, PERTH).

Distribution and habitat. Distributed from the Lake Grace and Newdegate areas southwards to Ongerup and west towards Wagin. The distribution is more restricted than that outlined by Hill and Johnson (1992). A collection from 4.5 km W of Tammin (*L. Johnson* 9112 & *M. Johnson*) cited in Hill and Johnson (1992), is considered to be a partially naturalized, planted population of *E. spathulata* (Nicolle and French pers. obs., Sept. 2000). It occurs as several old trees and many younger saplings adjacent to a disused gravel pit on a lateritic rise, growing with both native vegetation and other introduced eucalypt species.

E. spathulata occurs in saline drainage lines and depressions, often fringing salt lakes, in heavy grey clay soils. It often forms ±pure stands, sometimes associated with *E. extensa, E. kondininensis* and *E. occidentalis*.

Conservation status. Under medium to long-term threat from rising saline groundwater, causing salinization of low-lying habitats. Recorded from Flagstaff and Lake Magenta Nature Reserves.

Notes. Hybrids are known with *E. platypus* (common in the Ongerup area, i.e. the type locality of *E. platypus* var. *heterophylla* – Brooker and Hopper 2002) and *E. tenera*.

1b. Eucalyptus spathulata Hook. subsp. **salina** Nicolle & Brooker, *subsp. nov.*

A subspecie typica foliis adultis viridibus plerumque leviter latioribus (3.5–7 mm wide); inflorescentiis 3 vel 7 floribus (constanter 7 floribus in subsp. *spathulata*); et fructibus majoribus (6–8 mm long x 6–6.5 mm wide).

Typus: West of Pingaring on Carganocking–Pingaring road, Western Australia, 32° 45' 41"S, 118° 24' 02"E, 16 Sep. 2000, *D. Nicolle* 3435 & *M. French* (*holo*: PERTH 05788625; *iso*: AD, CANB). (Figure 2D)

Distinguished from subsp. *spathulata* by the generally slightly broader (3.5–7 mm wide), green adult leaves; the 3- and/or 7- flowered inflorescences (consistently 7-flowered in subsp. *spathulata*) and the larger fruits (6–8 mm long x 6–6.5 mm wide). (Figure 2C)

Specimens examined: WESTERN AUSTRALIA: 0.1 km W of Dornock Rd along the Carganocking–Pingaring Rd, 32° 45' 27"S, 118° 30' 13"E, 12 Sept. 1997, *P.J. White* 1049 (PERTH); Carganocking–Pingaring Rd, 6.1 km E of Kulin–Lake King Rd, 32° 44' 41"S, 118° 22' 14"E, 19 Sept. 1997, *P.J. White* 1056 (PERTH); Mt Stirling Road, South Tammin, 31° 53' 33"S, 117° 30' 11"E, 23 Nov. 2000, *N. McQuoid* 563 (PERTH); Cnr Bruce Rock–Quairading Rd and Badjaling South Rd, 31° 58' 53"S, 117° 29' 16"E, 14 July 2001, *D. Nicolle* 3805 & *M. French* (CANB, PERTH); Mt Stirling Road, NE of Quairading, 31° 53' 42"S, 117° 30' 20"E, 14 July 2001, *D. Nicolle* 3806 & *M. French* (CANB, PERTH); 2.7 km east from Koorikin Rd on Corrigin–Kondinin Rd, 32° 27' 21"S, 118° 10' 10"E, 15 July 2001, *D. Nicolle* 3809 & *M. French* (CANB, PERTH); N edge of Yenyening Lakes, Salt River system, SE of Beverley, 32° 13' 56"S, 117° 13' 52"E, 19 Oct. 2002, *M. French* 1461 (PERTH).

Distribution and habitat. E. spathulata subsp. *salina* is restricted to the Salt River drainage system in the northern part of the southern wheatbelt, to the north of subsp. *spathulata*. It is known only from scattered populations from the north of Quairading south-east to Pingaring. It occurs in saline drainage

lines and flats, often in small, more or less pure stands, sometimes associated with *E. sargentii* subsp. *sargentii* and *E. myriadena*.

Conservation status. Known from a few, scattered stands, all of which are under threat from spreading and increased salinization. A few individuals are known on the edge of Badjaling Nature Reserve. Further survey is needed to establish the extent of populations following which this subspecies may fulfil the requirements for Western Australia's schedule of Declared Rare Flora. Conservation Codes for Western Australian Flora: Priority Three.

Etymology. From the Latin *salinus*, of salt, alluding to the habitat and also to the Salt River drainage system, on which this subspecies occurs.

Notes. Although differences between this subspecies and typical *E. spathulata* are relatively minor, the two subspecies are separable both in the field and as preserved herbarium specimens. The two subspecies are restricted to different drainage systems, with subsp. *spathulata* restricted to the westerly tending Blackwood River and upper Pallinup River catchments and inland drainage basins, and subsp. *salina* restricted to the more northerly tending Salt River (Avon River) system.

2. Eucalyptus orthostemon Nicolle and Brooker, *sp. nov.*

Affinis *Eucalypto spathulatae* sed habitu pluricauli ('mallee') et praesentia lignotuberis differt.

Typus: East of Yealering towards Kulin, Western Australia, 32° 35' 10"S, 117° 39' 52"E, 16 Sep. 2000, *D. Nicolle* 3426 & *M. French* (*holo*: PERTH 05788684; *iso*: AD, CANB). (Figure 3C)

Distinguished within the complex by its combination of lignotuberous, mallee habit, linear or almost linear, somewhat metallic ('glazed') olive-green adult leaves, erect staminal filaments, cream flowers, and the small to medium-sized, ±terete buds and fruits.

Mallee, 3–6 m tall. *Lignotuber* present. *Seedling leaves* shortly petiolate, linear to very narrow-lanceolate. *Adult leaves* linear or almost so, glossy, metallic blue-green to olive-green; lamina 30–80 mm long x 2–7 mm wide. *Inflorescences* (3-)7-flowered; peduncles very slightly flattened to terete, 3–10 mm long; pedicels terete, 2–5 mm long. *Flower buds* held erect, 11–12 mm long x 3–4 mm wide; operculum often narrower than hypanthium at join, cylindrical, ±smooth; *flowers* cream; stamens erect. *Fruit* held erect, distinct from pedicel, obconical to cupular-hemispherical, 5–7 mm long x 5.5–6.6 mm wide, smooth; valves 3 or 4. (Figure 3B)

Selected specimens examined: WESTERN AUSTRALIA: ¼ mile north of Wongan Hills, 21 May 1970, *M.I.H. Brooker* 2550 (CANB, PERTH); ½ mile north of Wongan Hills, 5 June 1969, *M.I.H. Brooker* 1827 (CANB, PERTH); 3 miles E of Cunderdin, 5 Feb. 1970, *K.R. Newbey* 3100, (CANB, PERTH); Between Pankie and Gabalong, 3 Oct. 1976, *J.S. Beard* 7989 (PERTH); Between Bolgart and Goomalling, 15 June 1977, *J.S. Beard* 8032 (CANB, PERTH); S of Tammin, 13 Oct. 1977, *J.S. Beard* 8088 (CANB, PERTH); Beaufort River crossing, 22 Nov. 1979, *G.J. Keighery* 2610 (PERTH); c. 12 km E of rail crossing at Carani, 26 Aug. 1982, *M.I.H. Brooker* 7584 (CANB, PERTH); 13.2 km NE of Calingiri on Wongan Hills Road, 28 Aug. 1983 *M.I.H. Brooker* 8285 (CANB, PERTH); 9 miles E of Wongan Hills, 31 Jan. 1986, *B.H. Smith* 642 (CANB, PERTH); Mosquito Hill, Bolgart East Road, 3 Sep. 1987, *M.I.H. Brooker* 9751 (CANB, PERTH); 0.9 km from Dowerin–Trayning road, on Minnievale Road, 3 Sep. 1988, *M.I.H. Brooker* 9748 (CANB, NSW, PERTH); 27.4 km S of Moora on Mogumber Road, 7 Aug. 1988, *M.I.H. Brooker* 10022 (AD, CANB,

PERTH); 4.6 km S of Kondut, 27 Aug. 1988, *K. Hill* 2935 (CANB, NSW, PERTH); E outskirts of Dumbleyung townsite, 33° 18' 47"S, 117° 44' 11"E, 19 Oct. 1992, *P.J. White* 352 (PERTH); 500 m E of junction–Nyabing South Rd and Wallacup Rd, 20 Oct. 1992, *P.J. White* 366 (PERTH); c. 500 m S Manuel Rd along Nyabing South Rd, 200 m W of road, 20 Oct. 1992, *P.J. White* 367 & *W. O'Sullivan* (PERTH); 1.9 km S Peterson Rd along N Datatine Rd, 33° 23' 47"S, 117° 51' 56"E, 23 Feb. 1993, *P.J. White* 482 (PERTH); Junction of Crosby Rd and Kukerin South Rd, Nature Reserve 26381, 33° 27' 34"S, 118° 07' 06"E, 23 Feb. 1993, *P.J. White* 485 (PERTH); Goomalling, 21 Oct. 1993, *P. White* 670 (CANB, PERTH); 0.7 km N of Watercarrin road along Cunderdin–Wyalkatchem road, 21 Oct. 1993, *P.J. White* 673 (CANB, PERTH); Nature Reserve 15197, 8 km E White Wells Rd/Nippering Rd junction, along White Wells Rd, 33° 12' 20"S, 117° 44' 08"E, 7 Nov. 1993, *P.J. White* 687 (CANB, PERTH); South of Moora, 30° 53' 09"S, 116° 01' 40"E, 25 Jan. 1996, *D. Nicolle* 1657 (PERTH); 0.9 km W of Bullaring along side railway line, 32° 30' 15"S, 117° 44' 10"E, 12 Sep. 1997, *P.J. White* 1043 (PERTH); 1.2 km WNW of Bullaring, 32° 29' 29"S, 117° 43' 44"E, 12 Sep. 1997, *P.J. White* 1045 (PERTH); Yenyenning Lakes Ski Club access rd, 1.7 km from Mears Rd, 32° 13' 46"S, 117° 10' 30"E, 21 Sep. 1997, *P.J. White* 1024 (PERTH); Gravel pit, Wickepin–Kulin Rd, 8.8 km E of Wickepin, 25 Sep. 1997, *P.J. White* 1060 (NSW, PERTH); Peter Valley Rd, NW of Cranbrook, E of Albany Hwy, 34° 10' 58"S, 117° 29' 51"E, 1 Nov. 1997, *M. French* 329 (PERTH); 16 km S of Corrigin–Brookton Road, S of Bullaring, 28 Apr. 1999, *A.V. Slee* 4078 (CANB, PERTH); Gabalong East Road, NW of Wongan Hills, 30° 43' 20"S, 116° 27' 36"E, 25 May 2000, *M. French* 1205 (PERTH); North-east of Calingiri, 31° 03' 51"S, 116° 29' 37"E, 13 Jan. 2001, *D. Nicolle* 3691 & *M. French* (CANB, PERTH); Grays Road, S of Harrismith, 33° 02' 49"S, 117° 53' 33"E, 21 Jan. 2001, *D. Nicolle* 3731 & *M. French* (CANB, PERTH; 7.4 km on Toolbrunup Road from Great Southern Hwy, SE of Tambellup, 34° 05' 25"S, 117° 44' 45"E, 10 Feb. 2001, *D. Nicolle* 3776 & *M. French* (CANB, PERTH); 2.1 km from Yonka Rd on Peter Valley Rd, N of Cranbrook, 34° 11' 01"S, 117° 30' 00"E, 10 Feb. 2001, *D. Nicolle* 3783 & *M. French* (AD, CANB, PERTH); Pingrup–Nyabing Rd, 33° 35' 12"S, 118° 26' 38"E, 30 July 2002, *D. Nicolle* 4428 & *I. Brooker* (PERTH); Damboring West Rd, S of Pithara, 30° 31' 26"S, 116° 40' 02"E, 3 Aug. 2002, *D. Nicolle* 4442 & *M. French* (CANB, PERTH).

Distribution and habitat. Of widespread but scattered distribution in the central wheatbelt of south-west Western Australia, from Miling and south of Pithara in the north, south to the Gordon River north of Cranbrook. It is commonly associated with sub-saline and saline flats or drainage lines, where it may be the dominant mallee species, but also occurs on poorly drained low rises of white to grey loams with ironstone gravel. Associated species include *E. annulata, E. arachnaea* subsp. *arachnaea, E. brachycorys, E. celastroides* subsp. *virella, E. erythronema* var. *erythronema, E. flocktoniae* subsp. *flocktoniae, E. hebetifolia, E. kochii* subsp. *kochii, E. kondininensis* sens. lat., *E. latens* sens. lat., *E. neutra, E. occidentalis, E. phenax* subsp. *phenax, E. tenera, E. uncinata, E. vegrandis* and *E. wandoo* subsp. *wandoo*. (Figure 3A)

Conservation status. This species is widespread and relatively common, and has been recorded from several nature reserves. The species is under some long-term threat by dryland salinization caused by large-scale vegetation clearance within the central wheatbelt.

Flowering period. September to February.

Etymology. From the Greek *ortho* (straight) and *stemon* (thread – stamen), referring to the erect stamens in contrast to *E. vegrandis*.

Notes. This species is one of the many variants traditionally included in *E. spathulata* var. *grandiflora*. More significantly, *E. orthostemon* is the common species more recently included in *E. vegrandis*, the type of which is relatively restricted and generally more southerly in distribution.

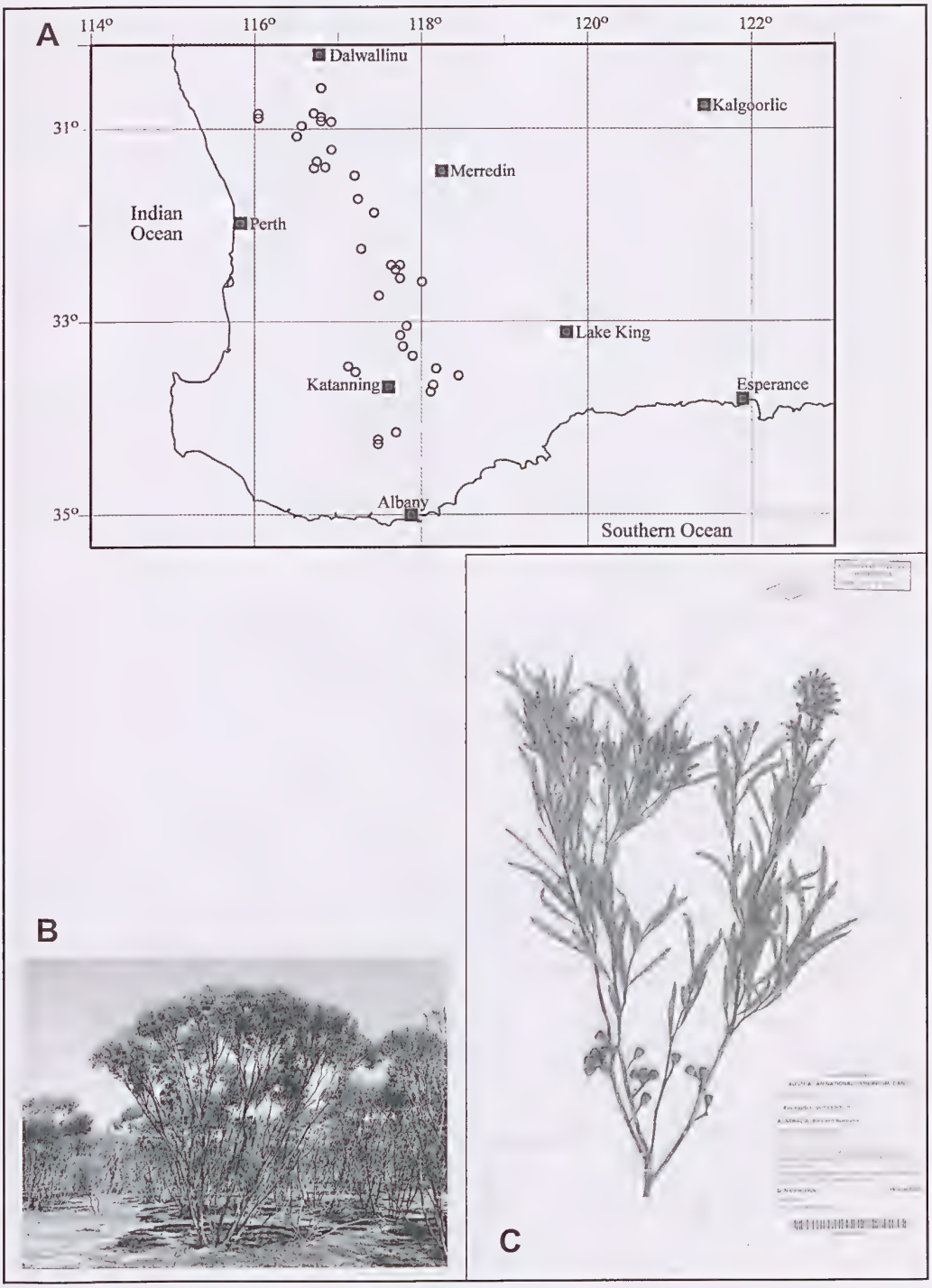

Figure 3. A – Distribution of *E. orthostemon* O in Western Australia; B – Habit of *E. orthostemon* at type locality (East of Yealering towards Kulin, 32° 35' 10"S, 117° 39' 52"E); C – Isotype of *E. orthostemon* (*D. Nicolle* 3426 *& M. French*).

E. orthostemon is most closely related to *E. spathulata* subsp. *spathulata* and is distinguished consistently by the lignotuberous, mallee habit (Figure 3B). These two species have a more distant relationship to *E. vegrandis*, which is distinguished most readily by the inflexed staminal filaments.

E. orthostemon can be observed growing sympatrically with *E. vegrandis* south-east of Tambellup. The two species are readily distinguished at this locality on the basis of stamen arrangement. Two putative hybrids between the two species were observed at this site (one collected: see appendix).

Hybrids are also known with *E. arachnaea* subsp. *arachnaea, E. erythronema* var. *marginata* and *E. wandoo* subsp. *wandoo* (see appendix).

3. Eucalyptus alipes (L.A.S. Johnson & K.D. Hill) Nicolle & Brooker, *stat. nov.*

Eucalyptus suggrandis L.A.S. Johnson & K.D. Hill subsp. *alipes* L.A.S. Johnson and K.D. Hill. *Telopea* 4(4): 581 (1992). – *Type*: 46.0 km N of Coolgardie–Hyden road on Southern Cross road, Western Australia, *K.D. Hill* 2894, 26 Aug. 1988 (*holo*: NSW; *iso*: CANB, PERTH 05087910).

Distinguished within the complex by the combination of non-lignotuberous, mallet habit, narrow-elliptical adult leaves, 3-flowered inflorescences, erect staminal filaments, cream flowers and the medium-sized to large, 2-angled buds and fruits.

Mallet (obligate seeder), 3–8 m tall. *Lignotuber* absent. *Seedling leaves* shortly petiolate, narrow-elliptical to lanceolate. *Adult leaves* narrow-elliptic, glossy, olive-green; lamina 35–60 mm long x 4–8 mm wide. *Inflorescences* 3-flowered; peduncles flattened, 8–14 mm long; pedicels angular to flattened, 6–8 mm long. *Flower buds* held erect, 12–16 mm long x 4.5–6 mm wide; operculum narrower than hypanthium at join, cylindrical to hemispherical, ±smooth; *flowers* creamy-white; stamens erect. *Fruit* held erect, tapering from pedicel, obconical, 10–12 mm long x 7–8 mm wide, usually 2-ribbed from pedicel; valves 3 or 4. (Figure 4B)

Distribution and habitat. Distributed from the Hyden scrub (between Hyden, Coolgardie and Norseman) south to east of Lake King and west nearly to Narembeen. *E. alipes* occurs in sub-saline to saline drainage lines and depressions in heavy soils or saline sands, often in pure whipstick mallet stands, or sometimes associated with (especially on the edges of such habitats) *E. celastroides* subsp. *virella*, *E. eremophila*, *E. exigua, E. kondininensis, E. neutra, E. salicola* and *E. sheathiana.* (Figure 4A)

Selected specimens examined: WESTERN AUSTRALIA: 44 km E of Hyden on Norseman track, 3 Oct. 1975, *M.I.H. Brooker* 4978 (NSW, PERTH); 5 km N of Hyden on road to Southern Cross, 13 Sep. 1978 *D.F. Blaxell* 1731 (PERTH); 2.1 km W of Bold Rock on track to Rabbit Proof Fence, 40 km NE of Hyden, 21 Sep. 1978, *S.D. Hopper* 1138 (PERTH); 1 km S of Holland track gate along State Barrier Fence, 32° 26' 43"S, 119° 26' 36"E, 16 Dec. 1992, *P.J. White* 448 (PERTH); 11.5 km SE of the Lake King–Norseman Rd on the E side of the State Barrier Fence, 33° 12' 09"S, 120° 08' 12"E, 16 Dec. 1992, *P.J. White* 450 (PERTH); 14.6 km NW of Hyden–Norseman Rd along Vermin Proof Fence, 32° 29' 54"S, 119° 17' 41"E, 27 Feb. 1993, *P.J. White* 541, 542, 545 (CANB, PERTH); 2.2 km SW of Mount Walker School on E edge of salt lake, 32° 03' 21"S, 118° 41' 52"E, 28 Feb. 1993, *P.J. White* 550, 551 (PERTH); Hewson Rd, 9.9 km N of Newdegate–Ravensthorpe Rd, 33° 00' 53"S, 119° 30' 55"E, 31 Mar. 1993, *P.J. White* 587 (CANB, PERTH); Hewson Rd, 7.4 km N of Newdegate–Ravensthorpe Rd, 33° 00' 53"S, 119° 30' 55"E, 31 Mar. 1993, *P.J. White* 588 (CANB, PERTH); 4.1 km W of Cross Rds between Three Star Lake and Peter Soak, 33° 05' 00"S, 120° 34' 23"E, 2 Apr. 1993, *P.J. White* 631 (CANB, PERTH); Lake King–Norseman Rd, 49.6 km E of Vermin Proof Fence,

32° 52' 41"S, 120° 25' 30"E, 3 Apr. 1993, *P.J. White* 637 (PERTH); 11 km E of Hyden–Ravensthorpe Rd along lake Carmody Rd, 32° 27' 43"S, 119° 09' 44"E, 3 Apr. 1993, *P.J. White* 642 (PERTH); Graham Rock, c. 1 km N of access track along private property boundary, 32° 27' 14"S, 119° 03' 26"E, 24 Nov. 1993, *P.J. White* 757, *758* (AD, MEL, NSW, PERTH); Newdegate, 1.8 km east of Magenta Rd along Parsons Rd (Hoskins Rd), 33° 09' 15"S, 119° 02' 51"E, 10 Dec. 1993, *P.J. White* 701 (CANB, PERTH); Just SW of Varley Rock which is E of Hyden–Varley road, N of Holt Rock (town), 32° 38' 04"S, 119° 21' 46"E, 1 May 1999, *A.V. Slee* 4101 (CANB, PERTH); 0.7 km from Soldiers Rd on track around salt pan, 3.5 km W of Bailey Rd, E of Narembeen, 32° 02' 13"S, 118° 32' 41"E, 4 Sep. 1999, *W. O'Sullivan* 710 (PERTH); 11.1 km E of Narembeen–Muntadgin Rd along Soldiers Rd, 500 m S of road, 32° 02' 17"S, 118° 32' 14"E, 25 Sep. 1997, *P.J. White* 1065 (PERTH); Lake Gounter Nature Reserve, NW of Hyden on Worland Hill Rd, 32° 23' 49"S, 118° 49' 19"E, 21 Feb. 1999, *M. French* 770 (PERTH); S of crossroads on Forrestania–Southern Cross road, 32° 33' 31"S, 119° 45' 45"E, 6 Nov. 1999 *M. French* 1087 (PERTH); 15.8 km S of Lake Cronin crossroads towards South Ironcap, 32° 33' 40"S, 119° 45' 54"E, 10 Nov. 2000, *D. Nicolle* 3668 & *M. French* (CANB, PERTH); 3.3 km S of Varley towards Lake King, 32° 49' 17"S, 119° 31' 46"E, 11 Nov. 2000, *D. Nicolle* 3675 & *M. French* (AD, CANB, PERTH); NW of Hyden on the Vermin Proof Fence, 32° 20' 14"S, 119° 17' 39"E, 14 Apr. 2001, *M. French* 1305 (PERTH); On Emu Fence Rd, S of Southern Cross, 31° 57' 00"S, 119° 18' 24"E, 15 Apr. 2001, *M. French* 1311 (PERTH); 2.2 km S from Biddy-Cam Rd on Hewson Rd, 33° 00' 41"S, 119° 31' 09"E, 1 Aug. 2002, *D. Nicolle* 4438 & *I. Brooker* (AD, CANB, PERTH); 42.5 km N from Hyden towards Narembeen, 32° 05' 53"S, 118° 49' 15"E, 2 Aug. 2002, *D. Nicolle* 4439 & *I. Brooker* (CANB, PERTH).

Conservation status. Widespread, but of scattered occurrence and restricted to low-lying areas and may be under long-term threat from salinization. Scattered through the western part of the Hyden scrub and known from Lake Gounter Nature Reserve.

Notes: E. alipes is most closely related to *E. mimica*, the main distinguishing feature being degree of bud and fruit ornamentation (2-angled in *E. alipes*; 4-winged and square in *E. mimica*). *E. alipes* also generally lacks the sepals seen in *E. mimica*. These two mallet species show a more distant relationship (although clearly still closely related) to *E. suggrandis*. *E. alipes* is a non-lignotuberous mallet (an obligate seeder; Figure 4B) whereas *E. suggrandis* is a lignotuberous mallee (a resprouter).

E. alipes grades into *E. spathulata* subsp. *salina* in the west of its range, between Narembeen and Kondinin (see appendix). *E. alipes* differs from *E. spathulata* in the broader, narrow-elliptical adult leaves, the consistently three-flowered inflorescences (3- or 7-flowered in *E. spathulata*), and the larger, 2-ribbed buds and fruits (terete in *E. spathulata*) on longer peduncles. *E. alipes* also tends to be a smaller mallet forming whipstick stands (woodland mallet in *E. spathulata*).

4. Eucalyptus mimica Brooker & Hopper, *Nuytsia* 14(3): 344 (2002).

Type: 11.3 km along Old Ravensthorpe Road from Newdegate–Lake King road, Western Australia, 24 Nov. 1987, *M.I.H. Brooker* 9811 (*holo*: PERTH 1391925; *iso*: AD, CANB, MEL, NSW).

Distinguished within the complex by its combination of non-lignotuberous, mallet habit (an obligate seeder), narrow-elliptical adult leaves, loosely-erect, 3-flowered inflorescences, erect staminal filaments, cream flowers and medium-sized, 4-ribbed to winged and square buds and fruits.

Mallet (obligate seeder), 4 to 10 m tall. *Lignotuber* absent. *Seedling leaves* shortly petiolate, narrow-elliptical to lanceolate. *Adult leaves* narrow-elliptic, glossy, olive-green; lamina 50–85 mm long x 5–8 mm

wide. *Inflorescences* held loosely erect, 3-flowered; peduncles slightly flattened, 12–21 mm long; pedicels angular to ribbed in transverse section, 6–14 mm long. *Flower buds* held erect, 14–20 mm long x 4.5–5.5 mm wide; hypanthium 4-ribbed to winged, operculum often narrower than hypanthium at join, cylindrical to bluntly to sharply-conical, ±smooth to ribbed; *flowers* cream; stamens erect. *Fruit* held erect, tapering from pedicel, narrowly obconical, 11–16 mm long x 8–10 mm wide (including ribs), 3 or 4 ribbed; valves 3 or 4.

Brooker and Hopper (2002) describe two subspecies with overlapping distributions based on cited specimens. This is due to specimens of *E. suggrandis* subsp. *promiscua* being included in both subspecies of *E. mimica*. Here, we refine the definition of *E. mimica* to that of non-lignotuberous mallets (obligate seeders) only. Under this revised circumscription, the distribution of the two subspecies do not overlap, but rather form a geographical replacement pattern with the more restricted subsp. *continens* occurring to the south-west of subsp. *mimica*.

The two subspecies are distinguished by operculum structure. Contrary to Brooker and Hopper (2002), we do not recognise habit differences between the two subspecies. Both subspecies are obligate seeders.

4a. Eucalyptus mimica Brooker & Hopper subsp. **mimica**

Distinguished from subsp. *continens* by the sepaline whorl forming distinct sepals which may not be persistent, often being shed before anthesis.

Selected specimens examined: WESTERN AUSTRALIA: 19.6 km SE of highway E of Newdegate on Old Ravensthorpe Rd, 15 May 1988, *L.A.S. Johnson* 9086 & *M. Johnson* (NSW, PERTH); 6 km S of Lee Rd along Old Ravensthorpe Rd, 14 Sep. 1988, *A. Napier & A. Kelly* 303 (PERTH); 23 km E of Newdegate on Lake King Rd, 14 Sep. 1988, *A. Napier & A. Kelly* 304 (PERTH); 8.9 km N of Newdegate-Ravensthorpe Rd on Newdegate North Rd, 15 Sep. 1988, *A. Napier & A. Kelly* 305 (PERTH); 19 km SE from Newdegate along the Old Ravensthorpe Rd, 33° 13' 03"S, 119° 09' 57"E, 23 Oct. 1992, *P.J. White* 398 (PERTH); 26.2 km from Newdegate along the Old Ravensthorpe Rd, 23 Oct. 1992, *P.J. White* 399 (PERTH); Newdegate, 7.1 km E Magenta Rd along Breed Rd, 33° 11' 05"S, 119° 11' 59"E, 10 Nov. 1993, *P.J. White* 703 (PERTH); 11.4 km S of Newdegate-Lake King Rd on Old Ravensthorpe Rd, 33° 09' 40"S, 119° 09' 54"E, 2 May 1999, *A.V. Slee* 4115 (CANB, PERTH); Alymore Rd, just N of Buniche Rd, 32° 56' 53"S, 118° 53' 19"E, 29 July 2002, *D. Nicolle* 4414 & *I. Brooker* (AD, CANB, PERTH); 11.1 km from Lake King–Newdegate Rd on Old Ravensthorpe Rd, 33° 09' 23"S, 119° 09' 41"E, 30 July 2002, *D. Nicolle* 4415, 4416 & *I. Brooker* (CANB, PERTH).

Distribution and habitat. Only known from the Newdegate area, to the north, east and south of Newdegate. It occurs in heavy soils or low-lying sands, often in locally saline depressions or drainage lines. Associated eucalypts include *E. celastroides* subsp. *virella, E. extensa, E.kondininensis, E. myriadena, E. olivina* and *E. sargentii* subsp. *sargentii*. (Figure 4A)

Conservation status. Poorly known and in need of further survey. Many populations exist as remnant roadside stands and it is not recorded from a conservation reserve. Conservation Codes for Western Australian Flora: Priority Three.

Notes. The taxon was recognised as having affinity with *E. steedmanii* (Brooker and Hopper 2002) from which it differs in the narrower adult leaves and the smaller buds and fruit. *E. mimica* subsp. *mimica* is also restricted to low-lying, saline sites, unlike the non-saline habitat of *E. steedmanii*.

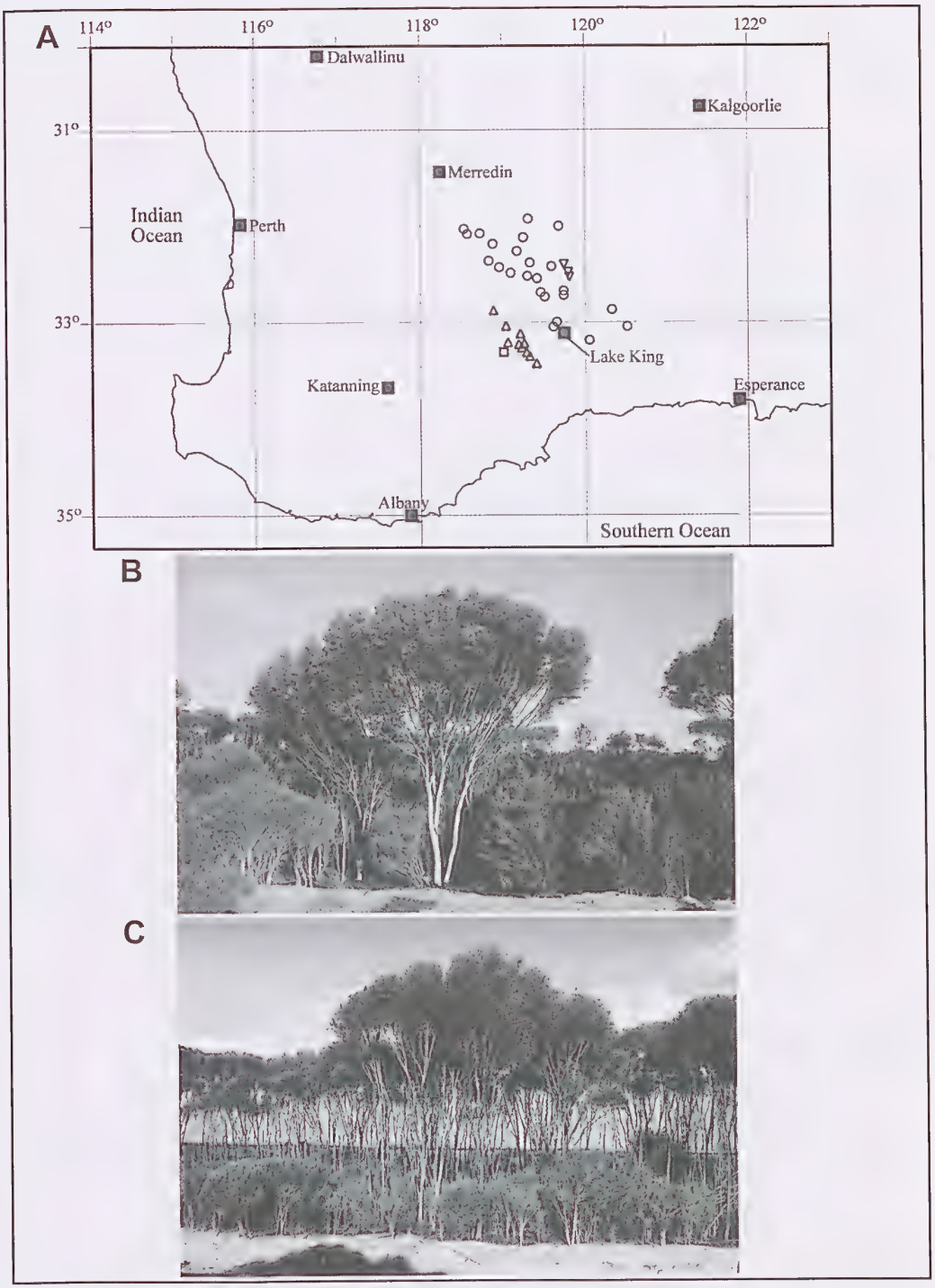

Figure 4. A – Distribution of *E. alipes* ○, *E. steedmanii* ▽, *E. mimica* subsp. *mimica* △ and subsp. *continens* □ in WA; B – Habit of *E. alipes* (2.2 km S from Biddy-Cam Rd on Hewson Rd, 33° 00' 41"S, 119° 31' 09"E); C – Habit of *E. mimica* subsp. *continens* near type locality (Lockhardt Rd, S of Newdegate, 33° 17' 07"S, 119° 01' 23"E).

4b. Eucalyptus mimica Brooker & Hopper **subsp. continens** Brooker & Hopper, *Nuytsia* 14(3): 345 (2002).

Type: 11 km S along Lockhardt Rd from Magenta Rd, Western Australia, 17 Dec. 1987, *M.I.H. Brooker* 9841 (*holo*: PERTH 1378163; *iso*: AD, CANB, MEL, NSW).

Distinguished from subsp. *mimica* by the sepaline whorl in the form of an outer operculum which is persistent to anthesis.

Specimens examined: WESTERN AUSTRALIA: 21.9 km S of hwy at Newdegate on Lockhardt Rd (to Pingrup), 15 May 1988, *L.A.S. Johnson* 9087 & *M. Johnson* (NSW, PERTH); Lockhardt Rd, 11 km S of Magenta Rd, 21 July 1988, *M.I.H. Brooker* 10007 (CANB, PERTH); 21.4 km S of Newdegate, 4.3 km N along Lockhardt Rd from Dykes Rd, 33° 17'20"S, 119° 01'15"E, 25 May 1989, *A. Napier & A. Kelly s.n.* (PERTH); Lockhardt Rd, S of Newdegate, 33° 17'07"S, 119° 01'23"E, 22 Nov. 1994, *D. Nicolle* 1114 (PERTH).

Distribution and habitat. Known only from the type locality, near Lake Lockhardt, south of Newdegate, occurring in a locally saline depression bordering a salt lake. It occurs in a pure stand abutting *E. sargentii* subsp. *sargentii*. Kelly *et al.* (1995) report (but do not cite) a population from near Mt Holland. This report appears to be erroneous and probably refers to *E. alipes*, which is known from the Mt Holland area. (Figure 4A, C)

Conservation status. Known from a single population spanning several kilometres where it is the dominant overstorey plant. It is certainly endangered from roadworks, inappropriate fire management and, in the longer term, rising saline groundwater. Conservation Codes for Western Australian Flora: Priority One.

Notes. Only one specimen cited in the protologue is not from the type population (Sullivan Soak – *D.L. Serventy* 229). Examination of this population in the field reveals a mallee habit and indicates it is *E. suggrandis* subsp. *promiscua.*

The retention of the intact, completely formed outer operculum till anthesis in *E. mimica* subsp. *continens* is a feature of many unrelated eucalypts, e.g. *E.* subser. *Continentes* Brooker (some of the box group of eucalypts, mainly of eastern Australia), but is otherwise unknown in *E.* sect. *Bisectae*.

5. Eucalyptus steedmanii C. Gardner, *J. Proc. Roy. Soc. W. Australia* 19: 87 (1933).

Type: Forrestania, S of Southern Cross, Western Australia, Feb. 1928, *H. Steedman s.n.* (*holo*: PERTH 1005960).

Distinguished within the complex by the combination of non-lignotuberous, mallet habit (an obligate seeder), somewhat erect to loosely pendulous 3-flowered inflorescences, erect staminal filaments, the cream or very rarely pink flowers and large, 4-winged buds and fruits.

Mallet (obligate seeder), 6–12 m tall. *Lignotuber* absent. *Adult leaves* narrow-elliptical to elliptical, often coarsely crenulate, glossy, olive-green; lamina 52–70 mm long x 11–16 mm wide. *Inflorescences* 3-flowered; peduncles slightly flattened, 17–26 mm long; pedicels angular to ribbed in transverse section, 8–13 mm long. *Flower buds* held somewhat erect to loosely pendulous, 22–25 mm long x 10–14 mm wide (including wings); hypanthium strongly 4-winged, operculum appearing narrower than hypanthium at join due to less prominent ornamentation, bluntly conical, ±smooth to slightly ribbed; *flowers* cream or

very rarely pink; stamens erect. *Fruit* held erect to loosely pendulous, tapering from pedicel, obconical, prominently 4-winged, 18–23 mm long x 13–16 mm wide (including wings); valves 4.

Specimens examined: Specimen data have been omitted due to the rarity of this species.

Distribution and habitat. Known from a small area between Wattle Rocks and Middle Ironcap, east of Hyden in Western Australia. It grows on low, broad rises in mallet woodland with other obligate seeders such as *E. salubris* and *E. urna*. (Figure 4A)

Conservation status. Declared as Rare Flora under Western Australian Government Legislation. The entire distribution of *E. steedmanii* suffered a wildfire in 1995, following which seedling regeneration and subsequent flowering has occurred. This species is well known and relatively common in cultivation in southern Australia.

Notes. Distinguished from *E. mimica* in the broader adult leaves and larger buds and fruits. It occupies somewhat elevated, non-saline sites unlike *E. mimica,* which is restricted to saline drainage lines and fringing salt lakes.

6. Eucalyptus suggrandis L.A.S. Johnson & K.D. Hill, *Telopea* 4(4): 580 (1992).

Type: Hamersley Drive, 32.5 km from Old Ongerup Rd, Fitzgerald River National Park, Western Australia, *K.D. Hill* 3147, 7 Sept. 1988 (*holo*: NSW; *iso*: CANB).

Distinguished within the complex by the combination of lignotuberous, mallee habit (resprouter), erect, 3- and/or 7-flowered inflorescences, erect staminal filaments and medium-sized buds and fruits continuous with and tapering to the 2-angled pedicel.

Mallee 1.5–6 m tall. *Lignotuber* present. *Seedling leaves* petiolate, narrow-lanceolate to ovate. *Adult leaves* narrow-elliptical to elliptical, glossy, slightly metallic blue-green to olive green; lamina 35–70 mm long x 5–18 mm wide. *Inflorescences* 3 or 7-flowered; peduncles slightly flattened to flattened, 7–23 mm long; pedicels angular to flattened, 1–5 mm long. *Flower buds* held erect, 10–18 mm long x 5–6.5 mm wide; operculum usually narrower than hypanthium at join, bluntly conical to cylindrical, ±smooth to densely minutely warty; *flowers* cream, very rarely pink to red; stamens erect. *Fruit* held erect, tapering from pedicel, obconical to somewhat barrel-shaped, 8–14 mm long x 6–10 mm wide, smooth to 2-ribbed from pedicel; valves 3 or 4.

E. suggrandis is distinguished most readily from the above related taxa by the mallee habit (*E. mimica, E. alipes* and *E. steedmanii* are all non-lignotuberous mallets – obligate seeders).

Two subspecies can be recognised differing primarily in bud morphology, with intergradation occurring in the Dragon Rocks area.

6a. Eucalyptus suggrandis L.A.S. Johnson & K.D. Hill subsp. **suggrandis**

Distinguished from subsp. *promiscua* primarily by the absence of sepals and early and clean shedding of an outer operculum. The adult leaves tend to be broader in this subspecies, the pedicels generally shorter and the buds and fruits less tapering to the pedicels.

Selected specimens examined: WESTERN AUSTRALIA: 20 km N of Hopetoun, 5 Oct. 1966, *P.G. Wilson* 5514 (CANB, PERTH); Lucy Rock, ca. 3 miles N of Holt Rock, 21 Sep. 1971, *K.M. Allan* 802 (CANB, MEL, PERTH); 106 km from Esperance along road to Ravensthorpe, Munglinup River crossing, 8 Jan. 1979, *M.D. Crisp* 4938 (CANB, PERTH); Ravensthorpe Range, 1.5 km SW of Mount Desmond, 9 Jan. 1979, *M.D. Crisp* 4974 (CANB, PERTH); 15 km E of Dunn Swamp, ca. 90 km ENE of Ravensthorpe, 15 Nov. 1980, *K.R. Newbey* 8130 (PERTH); 38 km W of Bald Rock, 33° 23' 53"S, 120° 58' 02"E, 3 Oct. 1983, *M.A. Burgman* 2654 & *S. McNee* (PERTH); Eldverton via Ravensthorpe, 4 Sep. 1984, *M.I.H. Brooker* 8659 (CANB, PERTH); 13.5 km from highway on Fitzgerald Rd, 18 Jan. 1985, *M.I.H. Brooker* 8808 (CANB, PERTH); 6 km S of highway on Fuss Rd, 11 Apr. 1985, *M.I.H. Brooker* 8930 (CANB, PERTH); 44 km W of Ravensthorpe–Albany Rd on Lake King Rd, 9 Nov. 1986, *K. Hill* 2381, *L.A.S. Johnson & D.F. Blaxell* (NSW, PERTH); 7.6 km from Ravensthorpe–Hopetoun Rd on Jerdacuttup Rd, 16 July 1987, *M.I.H. Brooker* 9718, 9719 (CANB, PERTH); Devil's Creek Rd, 10 km NW of Fitzgerald River National Park entrance, 6 Sep. 1988, *K. Hill* 3111 (CANB, NSW, PERTH); 2.2 km S of highway on Farrells Rd, 25 Nov. 1991, *M.I.H. Brooker* 10908 (CANB, PERTH); Ravensthorpe–Hopetoun Rd, 33° 44' 05"S, 120° 11' 28"E, 9 Dec. 1992, *D. Nicolle* 197 (PERTH); Track to Dragon Rocks, S of Hyden, 32° 46' 02"S, 119° 05' 26"E, 13 Dec. 1992, *D. Nicolle* 311 (PERTH); 9.2 km E of Hopetoun–Ravensthorpe Rd along Jerdacuttup Rd, 33° 44' 06"S, 120° 16' 47"E, 25 Feb. 1993, *P.J. White* 509 (CANB, PERTH); 7.1 km N of Jerdacuttup Rd along track past W side of Bandalup Hill, 33° 40' 09"S, 120° 22' 15"E, 25 Feb. 1993, *P.J. White* 510–514 (CANB, PERTH); 1.5 km W of West Point Rd along Bandalup Rd, 33° 33' 00"S, 120° 31' 17"E, 26 Feb. 1993, *P.J. White* 517, 519, 520 (CANB, PERTH); Foothills of Ravensthorpe range, Mount Short Rd, 0.2 km N of junction with Floater Rd, 33° 28' 23"S, 120° 01' 11"E, 31 Mar. 1993, *P.J. White* 600 (CANB, PERTH); 8 km from South Coast Hwy along Carlingup Rd, 33° 34' 47"S, 120° 02' 36"E, 1 Apr. 1993, *P.J. White* 603 (CANB, PERTH); SE corner Bradfords property/Dunn Rock Nature Reserve 36445, 1.8 km S Old Newdegate Rd, 33° 17' 21"S, 119° 35' 44"E, 11 Nov. 1993, *P.J. White* 704, 706, 707 (CANB, PERTH); Truslove area on Coolgardie–Esperance Hwy, 33° 22' 03"S, 121° 41' 36"E, 22 Nov. 1994, *D. Nicolle* 1100 (PERTH); Twertup Cottage, Fitzgerald River National Park, 34° 01' 29"S, 119° 22' 31"E, 23 Nov. 1994, *D. Nicolle* 1128 (PERTH); 5 km S of Telegraph Track on way to Quoin Head, Fitzgerald River National Park, 33° 57' 08"S, 119° 48' 09"E, 6 Apr. 1995, *M.I.H. Brooker* 12196W (AD, CANB, NSW, PERTH); SE Cascades on Cascades Rd, 33° 30' 59"S, 121° 10' 35"E, 15 Nov. 1997, *M. French* 342 (PERTH); Cocanarup Rd, 0.3 km from Albany–Esperance Hwy, 33° 38' 26"S, 119° 49' 51"E, 9 Nov. 1999, *W. O'Sullivan* 798 (PERTH); ca. 5 km SW of Cascades Rd on West Point Rd, 33° 21' 29"S, 120° 49' 32"E, 20 July 2001, *D. Nicolle* 3962 & *M. French* (CANB, PERTH); Collets Rd, Fitzgerald River National Park, 34° 07' 25"S, 119° 26' 54"E, 31 July 2002, *D. Nicolle* 4433 & *I. Brooker* (AD, CANB, PERTH); Hamersley Drive, Fitzgerald River National Park, 33° 53' 26"S, 119° 55' 41"E, 31 July 2002, *D. Nicolle* 4435 & *I. Brooker* (PERTH); 5.2 km from the new Cascade–Lake King road on the road to Lake Tay, 33° 10' 23"S, 120° 42' 44"E, 1 Aug. 2002, *D. Nicolle* 4436 & *I. Brooker* (AD, CANB, PERTH).

Distribution and habitat. Distributed from north of Bremer Bay eastwards to Truslove, north of Esperance, usually within approximately 80 km of the coast, but occurring inland towards Lake Tay and Dragon Rocks. Occurs in mixed mallee communities on sandplain to lateritic clays. Associated eucalypts include *E. proxima, E. astringens* subsp. *redacta, E. calycogona* subsp. *calycogona, E. cernua, E. cylindriflora, E. densa* subsp. *improcera, E. depauperata, E. flocktoniae* subsp. *flocktoniae, E. forrestiana, E. incrassata sens. lat., E. leptocalyx, E. micranthera, E. perangusta, E. phaenophylla, E. pileata, E. platypus* subsp. *platypus, E. pleurocarpa, E. quadrans, E. redunca, E. scyphocalyx, E. sporadica, E. tetraptera, E. tumida, E. valens* and *E. uncinata.* (Figure 5A)

Conservation status. This subspecies is widespread and well conserved in conservation reserves, including Fitzgerald River National Park.

Notes. The manuscript name *E.* 'verruculosa' has been used (Brooker and Kleinig, 1990) for populations of this taxon in the western part of Fitzgerald River National Park. These populations usually have slightly

broader adult leaves and marginally coarser buds and fruits than from populations further inland, but are consistent with *E. suggrandis* at the type locality. The coarser coastal populations of *E. suggrandis* follow a similar pattern to that seen in many other eucalypt taxa. At Twertup Cottage, *E. suggrandis* subsp. *suggrandis* appears to form hybrid swarms with *E. platypus* subsp. *platypus*. Six year old progeny from the *E. suggrandis* hybrid swarm at Twertup segregates towards both putative parents in cultivation (D. Nicolle, unpublished research). Putative hybrids are also known with *E. proxima* and *E. phaenophylla* (see appendix).

6b. Eucalyptus suggrandis L.A.S. Johnson & K.D. Hill **subsp. promiscua** Nicolle & Brooker, *subsp. nov.*

A subspecie typica structura operculata exteriore sero dehiscenti non perfecte in squamis, vel saepe sepala formanti differt.

Typus: NW corner of Harris Nature Reserve, E of Pingaring, Western Australia, 32° 48' 30"S, 118° 47' 19"E, 15 July 2001, *D. Nicolle* 3814 & *M. French* (*holo*: PERTH 06721060; *iso*: AD, CANB, NSW). (Figure 5B)

Distinguished from subsp. *suggrandis* primarily by the persistence of the outer operculum, which is either shed late or not cleanly and in scales, or by the common presence of sepals in the buds. The adult leaves are generally narrower in this subspecies, the pedicels longer and the buds and fruits tend to be more angled.

Selected specimens examined: WESTERN AUSTRALIA: 16 miles E of Pingrup, 6 miles W of Greenshield Soak, Feb. 1953 *D.L. Serventy* 183 (PERTH); 15 miles E Newdegate, 23 Apr. 1953, *R.D. Royce* 4185 (PERTH); Junction of Needilup Rd North and Newdegate Rd, 33° 24' 20"S, 118° 47' 40"E, 23 May 1989, *A Napier & A Kelly* 435 (PERTH); 14.5 km E of Lake Grace on road to Newdegate, 33° 06' 05"S, 118° 36' 54"E, 23 Oct. 1992, *P.J. White* 392 (PERTH); 1.9 km S of junction of Mallee Hill Rd along 14 Mile Rd, 33° 15' 03"S, 118° 44' 15"E, 13 Dec. 1992, *P.J. White* 436 (PERTH); 3.9 km N Reserve Rd along Lake Magenta Rd, 33° 32' 13"S, 119° 15' 17"E, 24 Feb. 1993, *P.J. White* 495 (PERTH); Junction of Kerr Rd and E boundary of Dragon Rocks Nature Reserve, 32° 49' 30"S, 119° 08' 25"E, 30 Mar. 1993, *P.J. White* 574, 575 (CANB, PERTH); Newdegate, Mallee Hill Rd, 3 km E of Beynon Rd, 33° 09' 18"S, 118° 55' 23"E, 10 Nov. 1993, *P.J. White* 699, 700 (CANB, PERTH); 1.8 km W of eastern boundary along track dividing CALM Reserve 29018 and Newdegate Research Station, 33° 08' 55"S, 118° 48' 56"E, 16 Sep. 1996, *P.J. White* 970 (PERTH); Pingrup–Townsend Rd, 23 May 1994, *T. Overheu* 647b (PERTH); 0.3 km W of Quiss Rd between Jerramungup and Ravensthorpe, 29 Aug. 1998, *M.I.H. Brooker* 12917 & *A.V. Slee* (AD, CANB, PERTH); Tarin Rock North Rd, NW of Lake Grace, 33° 03' 26"S, 118° 14' 32"E, 8 Sep. 1998, *M. French* 670 (PERTH); W of Newdegate on Lake Grace Rd, 33° 06' 08"S, 118° 52' 26"E, 12 Nov. 1998, *M. French* 759 (PERTH); Near Buniche Siding, road verge and railway reserve, 1.5 km along the Biddy-Cam Rd, 33° 00' 03"S, 118° 50' 38"E, 16 Aug. 1999, *E. Bishop* 108 (PERTH); Hyden–Newdegate Rd, S of Pingrup–Lake King Rd, 45 km NW of Newdegate, 4 Sep. 1999, *A.V. Slee* 4191 (AD, CANB, NSW, PERTH); Stewart Property, Loc. No. 1178, Lake Grace Shire, Aug. 2000, *J. & M. Stewart* 65 (PERTH); Between Lake Grace and Newdegate, 33° 06' 19"S, 118° 52' 31"E, 21 Jan. 2001, *D. Nicolle* 3720, 3721 & *M. French* (CANB, PERTH); Burngup North Road, north of Pingaring, 32° 43' 45"S, 118° 39' 38"E, 15 July 2001, *D. Nicolle* 3812 & *M. French* (CANB, PERTH); 17.6 km from Koornong Rd on Fitzgerald Rd, 33° 36' 43"S, 119° 31' 06"E, 21 July 2001, *D. Nicolle* 3974, 3975 & *M. French* (CANB, PERTH); 20.6 km W from Fitzgerald Rd on South Coast Hwy, 33° 50' 03"S, 119° 15' 34"E, 21 July 2001, *D. Nicolle* 3977 & *M. French* (CANB, PERTH); North Rd, NE of Pingaring, 32° 44' 41"S, 118° 39' 35"E, 29 July 2002, *D. Nicolle* 4413 & *I. Brooker* (CANB, PERTH); Ryan Rd, SW of Newdegate, 33° 24' 30"S, 118° 56' 43"E, 30 July 2002, *D. Nicolle* 4422 & *I. Brooker* (AD, CANB, PERTH); Sullivan Soak, Lake Magenta Nature Reserve, 33° 29' 05"S, 118° 59' 11"E, 30 July 2002, *D. Nicolle* 4425 & *I. Brooker* (CANB, PERTH).

Distribution and habitat. Distributed to the north and west of subsp *suggrandis*, in the area bounded approximately by Pingaring, Pingrup, Lake King and Jerramungup. It occurs as a component of mallee shrublands on pale brown or grey sandy loams. Associated species include *E. calycogona* subsp. *calycogona*, *E. depauperata, E. latens sens. lat., E. loxophleba* subsp. *gratiae, E. neutra, E. phaenophylla, E. pileata, E. salmonophloia* and *E. sheathiana.* (Figure 5A)

Conservation status. Well conserved in conservation reserves such as Lake Magenta Nature Reserve, Dragon Rocks Nature Reserve, Dunn Rock Nature Reserve and Harris Nature Reserve.

Etymology. From the Latin *promiscuus* (promiscuous, mixed), referring to the apparent morphological links of this taxon with *E. suggrandis* subsp. *suggrandis, E. mimica, E. alipes, E. orthostemon* and *E. goniocarpa* (the latter being part of the *E. eremophila* complex and is not discussed here).

Notes. Adult material of this subspecies is superficially similar to that of *E. mimica*, and indeed at least two specimens cited under *E. mimica* by Brooker and Hopper (2002) have proved to be *E. suggrandis* subsp. *promiscua* based on follow-up field examination. *E. suggrandis* is distinguished from *E. mimica* by is lignotuberous, mallee habit and its generally non-saline habitat.

7. Eucalyptus vegrandis L.A.S. Johnson & K.D. Hill, *Telopea* 4(4): 577 (1992).

Type: 5 km NW of Ongerup, Western Australia, *K.D. Hill* 337, *L.A.S. Johnson & D.F. Blaxell*, 23 Oct. 1983 (*holo*: NSW; *iso*: CANB, PERTH 1562088).

Distinguished within the complex by its combination of non-lignotuberous, mallet habit (obligate seeder), the linear to elliptical adult leaves, the erect, 7-flowered inflorescences, inflexed staminal filaments, creamy-white flowers and relatively small, 4 or 5-valved fruits.

Mallee, 2–6 m tall. *Lignotuber* present. Seedling leaves shortly petiolate, linear to elliptical. *Adult leaves* linear–elliptical, glossy, green to olive-green; lamina 30–60 mm long x 3–25 mm wide. *Inflorescences* 7-flowered; peduncles slightly flattened, 6–16 mm long; pedicels slightly angular, 1–3 mm long. *Flower buds* held erect, 7–12 mm long x 3–5 mm wide; operculum equal in width to slightly narrower than hypanthium at join, hemispherical to shortly cylindrical, ±smooth; *flowers* cream; stamens inflexed. *Fruit* held erect, relatively distinct from pedicel, obconical to cupular, thin-rimmed, 5–12 mm long x 5–8 mm wide, smooth; valves 4 or 5.

Two subspecies are recognised on the basis of adult leaf, bud and fruit morphology; subsp. *vegrandis* represents the narrow-leaved extreme of the species, while subsp. *recondita* is the more south-western, broad-leaved variant of *E. vegrandis*. The two subspecies form a geographical replacement pattern, with subsp. *recondita* occurring to the south and west of subsp. *vegrandis*. They form intermediate populations (intergrades) in geographically intermediate zones.

E. vegrandis is clearly distinguished from *E. orthostemon*, which has been included in *E. vegrandis* in the past, by the inflexed staminal filaments. Hill and Johnson (1992) erroneously described the stamen arrangement of *E. vegrandis* as erect, perhaps because their concept of *E. vegrandis* included the more northerly material described here as *E. orthostemon*. The staminal arrangement is correctly described for *E. vegrandis* by Brooker and Hopper (2002), however these authors had only assessed the type population at the time and made no comment with regard to more northerly *E. vegrandis* material (=*E. orthostemon*). *E. vegrandis* generally occurs to the south of *E. orthostemon*, although the two are

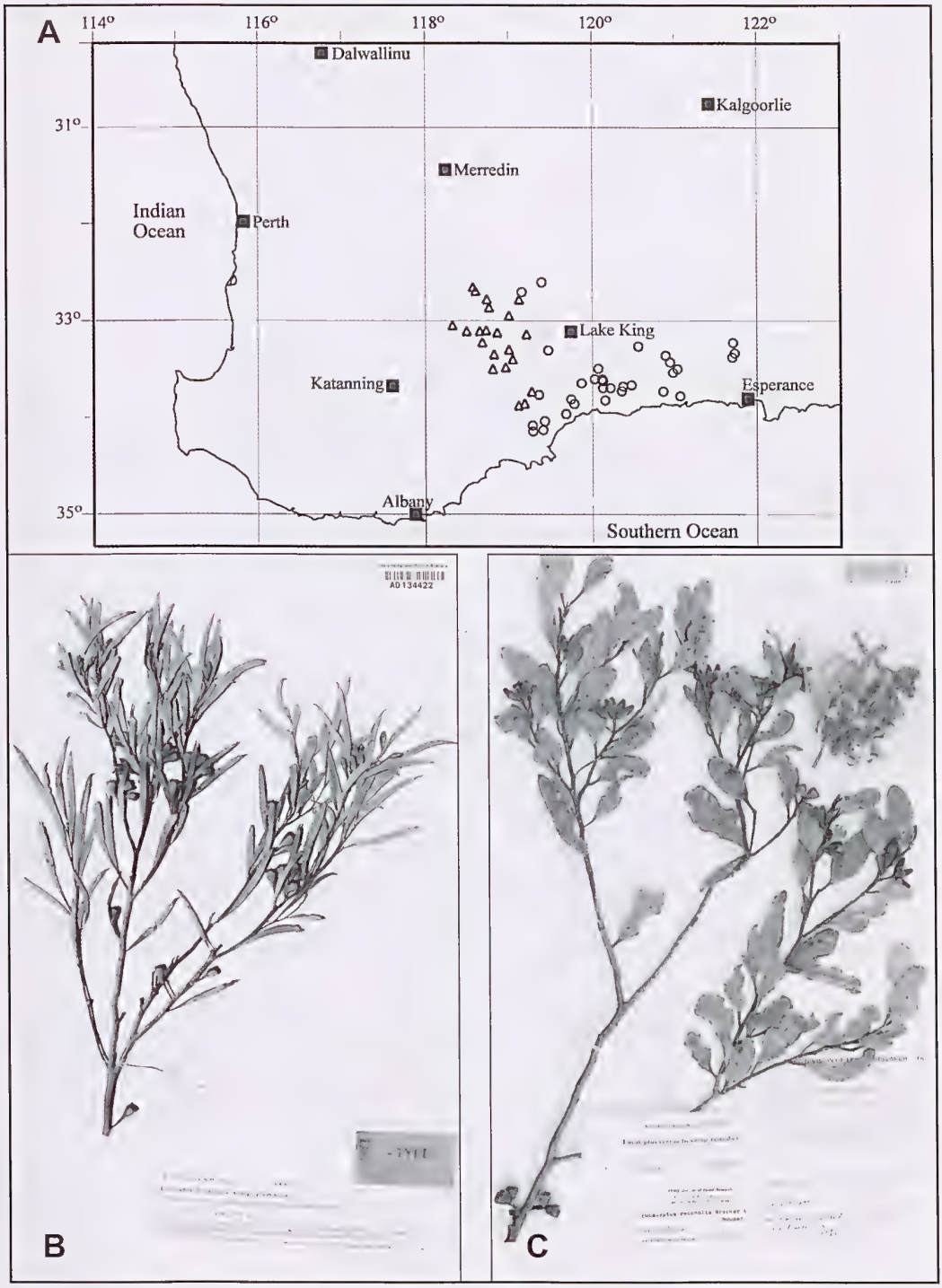

Figure 5. A – Distribution of *E. suggrandis* subsp. *suggrandis* O and subsp. *promiscua* Δ in Western Australia;
B – Isotype of *E. suggrandis* subsp. *promiscua* (*D. Nicolle* 3814 & *M. French*);
C – Isotype of *E. vegrandis* subsp. *recondita* (*M.I.H. Brooker* 7695).

sympatric in the northern part of the range of *E. vegrandis* and the far south-western part of the range of *E. orthostemon* (from north of Cranbrook to near Nyabing).

Two subspecies are recognized differing primarily by adult leaf morphology and also, less reliably, by bud and fruit size.

7a. Eucalyptus vegrandis L.A.S. Johnson & K.D. Hill subsp. **vegrandis**

Distinguished from subsp. *recondita* by the narrower, linear to narrowly elliptical adult leaves (30–55 mm long x 3–13 mm wide) and the generally smaller buds and fruits.

Selected specimens examined: WESTERN AUSTRALIA: 0.5 miles N of Gnowangerup, 31 Mar. 1956, *J.W. Green* 385 (PERTH); 2 miles NW of Ongerup, 9 Dec. 1961, *K.R. Newbey* 118 (PERTH); Due 3 miles NW of Ongerup, 12 Mar. 1962, *K.R. Newbey* 154 (PERTH); 9 miles E Ongerup, 7 Oct. 1962, *K.R. Newbey* 556 (PERTH); 6 miles E of Ongerup, 12 Jan. 1973, *H. Demarz* 4277 (PERTH); 6 km N of Borden, Stirling district, 15 Jan. 1979, *M.D. Crisp* 5174 (CANB, NSW, PERTH); 1.5 km ENE of Jerramungup, 96 km W of Phillips River Bridge, 4 May 1982, *S.D. Hopper* 2286, 2287 (PERTH); 2.2 km N of Bremer Bay turnoff on Jerramungup–Albany road, 8 June 1983, *M.I.H. Brooker* 8180 (CANB, PERTH); Needilup, almost opposite loading shed, 13 Jan. 1988, *M.I.H. Brooker* 9865 (CANB, PERTH); 5.9 km S along Carlawillup South Rd, 9 Mar. 1988, *M.I.H. Brooker* 9905 (CANB, PERTH); 19.9 km SE of Gnowangerup on Ongerup Rd, 31 Oct. 1988, *L.A.S. Johnson* 9165 *& B.G. Briggs* (NSW, PERTH); Gnowangerup townsite, W side – in vacant block, 15 Oct. 1991, *P.J. White* 270 (PERTH); Opposite loading shed at Needilup, 33° 57' 16"S, 118° 46' 11"E, 9 Dec. 1992, *D. Nicolle* 201 (PERTH); Due S of Gairdner, 34° 04' 21"S, 119° 02' 43"E, 9 Dec. 1992, *D. Nicolle* 207 (PERTH); Needilup, 29 Aug. 1998, *M.I.H. Brooker* 12915 (AD, CANB, PERTH); Hassell Highway, 15 km from Jerramungup towards Boxwood Hill, 34° 03' 59"S, 118° 56' 10"E, 5 May 1999, *A.V. Slee* 4131 (CANB, PERTH); Ongerup, NW edge of town on road to Gnowangerup, 33° 57' 48"S, 118° 28' 49"E, 5 May 1999, *A.V. Slee* 4139 (CANB, PERTH); Monjebup Rd, 10 km S of Ongerup–Boxwood Hill Rd, 34° 17' 39"S, 118° 36' 37"E, 19 Sep. 1999, *M.I.H. Brooker* 13042 (CANB, PERTH); Fence Rd, 0.2 km from Pingrup–Ongerup Rd, 33° 34' 47"S, 118° 28' 44"E, 16 Feb. 2000, *M.E. French* 1118 (PERTH); On Monjebup Rd, 4.8 km S at Telstra tower site, 34° 15' 10"S, 118° 37' 50"E, 4 March 2000, *M.E. French* 1166 (PERTH); Ca. 17 km north of Ongerup towards Lake Grace, 33° 49' 56"S, 118° 28' 47"E, 4 Nov. 2000, *D. Nicolle* 3563 *& M. French* (PERTH); 200 m from Katanning–Nyabing Rd on Shaw Rd, 33° 38' 19"S, 117° 54' 48"E, 26 Jan. 2001, *D. Nicolle* 3741 *& M. French* (PERTH); Communication tower on Monjebup Rd, 34° 15' 19"S, 118° 38' 00"E, 26 Jan. 2001, *D. Nicolle* 3745 *& M. French* (CANB, PERTH).

Distribution and habitat. Of scattered occurrence from between Katanning and Nyabing, south-east to the Bremer River area. It typically occurs in diverse mallee communities on sands to clay-loams. Associated eucalypt species include *E. annulata, E. calycogona* subsp. *calycogona, E. celastroides* subsp. *virella, E. extensa, E. longicornis, E. loxophleba* subsp. *loxophleba, E. neutra, E. phaenophylla, E. phenax* subsp. *phenax, E. platypus* subsp. *platypus, E. pleurocarpa, E. sporadica, E. thamnoides, E. vesiculosa*, and *E. xanthonema*. (Figure 6A)

Conservation status. Of scattered occurrence in highly fragmented agricultural land. Not known to occur in a nature reserve.

Notes. This subspecies occurs to the north and east of subsp. *recondita*, and is distinguished most readily by its narrower, linear to narrowly-elliptical leaves and also by its generally smaller buds and fruits.

7b. Eucalyptus vegrandis L.A.S. Johnson & K.D. Hill **subsp. recondita** Nicolle & Brooker, *subsp. nov.*

Ab subspecie *vegrands* foliis adultis latioribus et alabastris fructibusque majoribus distinguitur.

Typus: 2.3 km along N boundary fire trail from Bluff Knoll Rd, Stirling Range National Park, Western Australia, 7 Oct. 1982, *M.I.H. Brooker* 7695 (*holo*: CANB; *iso*: PERTH 1488368). (Figure 5C)

= *E.* 'recondita' *ined.* Brooker and Kleinig (1990).

Distinguished from subsp. *vegrandis* by the broad, elliptical adult leaves (42–60 mm long x 13–25 mm wide) and the generally larger buds and fruits.

Selected specimens examined: WESTERN AUSTRALIA: Tachalarup Rd, S of Stirling Range, 13 Apr. 1985, *M.I.H. Brooker* 8948 (CANB, PERTH); Sandalwood Rd, c. 3 km E of Amelup, 13 Apr. 1985, *M.I.H. Brooker* 8952 (CANB, PERTH); Kamballup Nature Reserve, SW corner, 27 Jan. 1988, *A. Napier & A. Taylor* 205 (CANB, PERTH); E of Amelup, N of Stirling Range, 34° 15' 49"S, 118° 14' 35"E, 8 Oct. 1996, *D. Nicolle* 1883 (PERTH); Formby South Rd, N of Stirling Range, 34° 11' 40"S, 118° 04' 24"E, 20 Jan. 1996, *D. Nicolle* 1621 & *P. Dunlop* (CANB, PERTH); 4.4 km from Hassel Rd on Yetermerup Rd, NE of Cranbrook, 34° 12' 43"S, 117° 54' 23"E, 10 Feb. 2001, *D. Nicolle* 3780 & *M. French* (CANB, PERTH); Off Climie Rd, W of Albany HW at Cranbrook, 34° 18' 43"S, 117° 30' 08"E, 10 Feb. 2001, *D. Nicolle* 3782 & *M. French* (PERTH).

Distribution and habitat. Occurs from the Cranbrook area in the west, eastwards through the Stirling Range and adjacent areas, although not on the range itself. It occurs in a variety of sites, although usually on heavy, poorly drained soils, from clayey lateritic rises to winter-wet depressions, often on somewhat saline sites. Associated eucalypt species include *E. annulata, E. astringens* subsp. *astringens, E. phaenophylla, E. pleurocarpa, E. thamnoides* and *E. wandoo* subsp. *wandoo*. (Figure 6A)

Conservation status. Although relatively widespread, this taxon is of scattered distribution, with many populations occurring as roadside populations or as fragmented remnants near salt lakes or saline drainage lines. It has been recorded from Stirling Range National Park.

Flowering period. Early spring.

Etymology. From the Latin *reconditus* (hidden, concealed), alluding to the fact that this taxon was assumed to be part of the *E. spathulata* complex and merely a broad-leaved form. Its distinction was only recognised in the field by flower bud dissections.

Notes. This is the south-westerly distributed subspecies of *E. vegrandis*, distinguished most readily from the typical subspecies by the broader, elliptical adult leaves and also by the generally larger buds and fruits.

8. Eucalyptus proxima Nicolle & Brooker, *sp. nov.*

Inter complexum habitu pluricauli (mallee), lignotuber formanti, foliis adultis ovatis vel late lanceolatis, inflorescentiis 7 floribus rigide inflexis, staminibus inflexis, floribus rubris vel rare cremeis, operculis non verrucatis et fructibus 4 valvis mediocribus distinguitur.

Typus: c. 6 km N of Jerdacuttup W. Rd on Hopetoun–Ravensthorpe road, 33° 39' 14"S, 120° 09' 47"E, 1 Aug. 2002, *M.I.H. Brooker* 13240 & *D. Nicolle* (*holo*: PERTH 07212836; *iso*: AD, CANB, MEL, NSW). (Figure 6D)

Distinguished within the complex by the combination of lignotuberous, mallee habit (resprouter), ovate to broad-lanceolate adult leaves, rigidly down-curved, 7-flowered inflorescences, inflexed and red or rarely creamy-yellow staminal filaments, non-warty operculum and medium-sized, 4-valved fruits.

Mallee 1–3 m tall. *Lignotuber* present. *Seedling leaves* distinctly petiolate, ovate to broad lanceolate. *Adult leaves* elliptical to broad-lanceolate, glossy, olive green; lamina 50–80 mm long x 15–20 mm wide. *Inflorescences* 7-flowered; peduncles strongly flattened, 13–18 mm long; pedicels stout, 1–4 mm long. *Flower buds* mostly rigidly down-turned, 9–13 mm long x 6–7 mm wide; operculum often narrower than hypanthium at join, hemispherical, ±smooth; *flowers* red, rarely creamy-yellow; stamens inflexed. *Fruit* rigidly down-curved, ±sessile to shortly pedicellate, obconical, 10–13 mm long x 9–12 mm wide ribbed; valves 3–5. (Figure 6C)

Selected specimens examined: WESTERN AUSTRALIA: 8.1 mls S Ravensthorpe on Hamersley River Rd, *s.dat.*, *R. Bowyer* 620802 (PERTH); Eyre Range, 2 Nov. 1965, *A.S. George* 7260 (PERTH); 1 km S of Ravensthorpe, 21 May 1967, *P.G. Wilson* 5877 (PERTH); 6.7 miles SE of Ravensthorpe, 26 Mar. 1968, *G.M. Chippendale* 415 (CANB, PERTH); 17.5 km SE of Ravensthorpe, Kundip, 9 Jan. 1979, *M.D. Crisp* 4979 (CANB, PERTH); Fitzgerald River National Park, 4 km W of Annie Peak, 11 Jan. 1979, *M.D. Crisp* 5030, 5031 (CANB, PERTH); 2.3 km along firebreak from Moir Rd, 33° 40' 30"S, 119° 58' 10"E, 10 Sep. 1987, *A. Napier & A. Taylor* 48 (PERTH); 18.6 km S of Ravensthorpe on Hopetoun Rd in Kundip area, 9 Nov. 1997, *M. Bennett* 21 (PERTH); 36.9 km N of Hopetoun towards Ravensthorpe, 33° 38' 16"S, 120° 09' 01"E, 5 Nov. 2000, *D. Nicolle* 3571 & *M. French* (PERTH).

Distribution and habitat. Restricted to the southern part of the Ravensthorpe Range and southwards to the Eyre Range and near Hamersley Inlet, over a maximum linear range of approximately 40 km. It occurs on broad rises in mallee shrubland vegetation. Associated eucalypt species include *E. astringens* subsp. *redacta*, *E. clivicola*, *E. densa* subsp. *improcera*, *E. flocktoniae* subsp. *flocktoniae*, *E. incrassata*, *E. phaenophylla*, *E. scyphocalyx* and *E. suggrandis* subsp. *suggrandis*. (Figure 6A)

Conservation status. Recorded from Fitzgerald River National Park. Conservation Codes for Western Australia Flora: Priority Four.

Flowering period. October–November.

Etymology. From the Latin *proximus* (nearest) referring to the species relationship to *E. cernua*.

Notes. Included in the concept of *E. cernua* by Brooker and Hopper (2002), but clearly distinguished by the lignotuberous mallee habit (Figure 6C). The distribution of *E. proxima* and *E. cernua* overlap in the southern part of the Ravensthorpe Range although generally *E. proxima* is more southern and western in distribution compared to *E. cernua*.

Flower colour cannot be used as a reliable distinguishing feature between *E. proxima* and *E. cernua* as both species can have red and pale yellow flowers on different individuals within a single population. *E. proxima* is commonly red-flowered and only occasionally pale-yellow-flowered, while *E. cernua* more often has pale yellow flowers.

9. Eucalyptus cernua Brooker & Hopper, *Nuytsia* 14(3): 342 (2002).

Type: 4.6 km N of Ravensthorpe–Albany road on Lake Grace Rd, Western Australia, 4 Sep. 1987, *M.I.H. Brooker* 8657 (*holo*: CANB; *iso*: AD, MEL, NSW, PERTH 1289519).

Distinguished within the complex by its combination of non-lignotuberous, mallet habit (obligate seeder); the narrow-ovate to broad-lanceolate adult leaves; the down-curved, 7-flowered inflorescences; the inflexed, red or creamy-yellow staminal filaments; the non-warty operculum and the medium-sized, 5–6-valved fruits.

Mallet (obligate seeder) 4–12 m tall. *Lignotuber* absent. *Seedling leaves* distinctly petiolate, ovate. *Adult leaves* narrow-ovate to broad-lanceolate; glossy, olive-green; lamina 50–95 mm long x 18–25 mm wide. *Inflorescences* 7-flowered; peduncles strongly flattened, 20–28 mm long; pedicels angular in transverse section, 0–4 mm long. *Flower buds* down-curved, 10–16 mm long x 6–10 mm wide; operculum narrower than hypanthium at join, hemispherical, ±smooth; *flowers* pale yellow or less commonly red; stamens inflexed. *Fruit* down-curved, tapering from pedicel, obconical to cupular, 12–17 mm long x 11–15 mm wide, coarsely ribbed; valves 5 or 6. (Figure 6B)

Selected specimens examined: WESTERN AUSTRALIA: 6 miles NW of Ravensthorpe, 5 Nov. 1969, *M.I.H. Brooker* 2290 (PERTH); Valley on N side of Mt McMahon, ca. 9 km direct NE of Ravensthorpe, 14 Sep. 1978, *L.D. Pryor & J.D. Briggs* 103 (CANB, PERTH); N side of Mt McMahon, NE of Ravensthorpe, 14 Sep. 1978, *D. Blaxell* 1737 (NSW, PERTH); 4.7 km NW of Highway 1 on Ravensthorpe–Lake King Rd, 10 Oct. 1984, *B. Briggs* 7717 & *L. Johnson* (AD, CANB, MEL, NSW, PERTH); 6.5 km along track near Bandalup Hill, 15 Jan. 1985, *M.I.H. Brooker* 8786 (CANB, PERTH); 8.4 km S of highway on Mason Bay Rd (S of Bandalup Hill),, 9 Nov. 1986, *K. Hill* 2364, *L.A.S. Johnson, D.F. Blaxell & M.I.H. Brooker* (NSW, PERTH); 3.1 km W of Ravensthorpe–Hopetoun road on Road 11, 9 Nov. 1986, *K. Hill* 2370, *L.A.S. Johnson, D.F. Blaxell & M.I.H. Brooker* (NSW, PERTH); Bandalup Hill area, 33° 41' 46"S, 120° 21' 58"E, 8 Dec. 1992, *D. Nicolle* 182 (PERTH); 5.4 km from Ravensthorpe on Lookout Rd to north, 7 Apr. 1995, *M.I.H. Brooker* 12201 (AD, CANB, NSW, PERTH); 0.4 km W of Carlingup Rd in Ravensthorpe Range on track leading to Vineyard Block, 33° 33' 42"S, 120° 07' 01"E, 9 Nov. 1997, *M. Bennett* 22 (PERTH); Bandalup Hill, ca. 31 km ESE of Ravensthorpe, 33° 39' 41"S, 120° 24' 02"E, 18 Feb. 1998, *G.F. Craig* 3616 (PERTH); Bandalup Hill, c. 31 km ESE of Ravensthorpe, 33° 37' 35"S, 120° 22' 47"E, 19 Feb. 1998, *G.F. Craig* 3645 (PERTH); N of Ravensthorpe on road to Lake King, 33° 32' 31"S, 120° 00' 16"E, 5 Nov. 2000, *D. Nicolle* 3574 & *M. French* (AD, CANB, PERTH).

Distribution and habitat. Restricted to the Ravensthorpe Range and Bandalup Hill and adjacent undulating areas in Western Australia, over a maximum linear range of less than 50 km. It grows in clayey soils, often in minor creeklines and depressions in undulating topography. Associated eucalypt species include *E. extensa, E. flocktoniae* subsp. *flocktoniae, E. leptocalyx, E. phenax* subsp. *phenax* and *E. stoatei*. (Figure 6A)

Conservation status. Relatively frequent and locally dominant and not considered to be at risk.

Flowering period. October to December.

Notes. Although the type of *E. cernua* clearly represents the non-lignotuberous mallet taxon often with pale yellow flowers, the notes in the protologue of the species (Brooker and Hopper 2002) indicate that these authors concept of the new species included that of *E. proxima*. The Latin diagnosis, description

and specimens cited in the protologue of *E. cernua* indicate both mallet variants (*E. cernua*) and mallee, commonly red-flowered variants (*E. proxima*) were included in the Brooker and Hopper concept of the new species. Here, we restrict the application of the name *E. cernua* to the type form i.e. the non-lignotuberous, mallet populations often with pale yellow but occasionally with red flowers. (Figure 6B)

Under the note of *E. vesiculosa*, Brooker and Hopper (2002) state that *E. cernua* (unlike *E. vesiculosa*) does not occur in pure stands. While *E. proxima* occurs as a component of mallee shrubland and as such is not known to occur in pure stands, *E. cernua*, as delimited here, often occurs in pure or almost pure mallet stands.

10. Eucalyptus vesiculosa Brooker & Hopper, *Nuytsia* 14(3): 341 (2002).

Type: Boxwood Hill–Ongerup Rd, 4 km W of Norman Rd, E of Monjemup Rd, Western Australia, 8 Apr. 1995, *M.I.H. Brooker* 12213 *& S.D. Hopper* (*holo*: CANB; *iso*: AD, NSW, PERTH 05698952).

Distinguished within the complex by its combination of non-lignotuberous, mallet habit (obligate seeder), elliptical to orbicular adult leaves; rigidly down-curved, 7-flowered inflorescences; inflexed staminal filaments, red flowers, warty operculum and large, 5 to 7-valved fruits.

Mallet (obligate seeder) 3–6 m tall. *Lignotuber* absent. *Seedling leaves* distinctly petiolate, ovate. *Adult leaves* broad-elliptical to almost orbicular, glossy, olive-green; lamina 40–45 mm long x 20–35 mm wide. *Inflorescences* 7-flowered; peduncles broadly flattened, 15–18 mm long; pedicels angular, 0–4 mm long. *Flower buds* rigidly down-turned, 15–18 mm long x 8–11 mm wide; operculum narrower than hypanthium at join, hemispherical, prominently warty; *flowers* red; stamens inflexed. *Fruit* rigidly down-turned, tapering from pedicel, obconical to cupular, 13–18 mm long x 14–19 mm wide, coarsely ribbed; valves 5 to 7.

Specimens examined: WESTERN AUSTRALIA: Between Ongerup and Borden, June 1972, *Schoolteacher s.n.* (PERTH); Boxwood Hill–Ongerup Rd, between Norman Rd and Monjemup Rd at edge of Corackerup Nature Reserve, 34° 13' 06"S, 118° 39' 14"E, 5 May 1999, *A.V. Slee* 4133 (CANB, PERTH); Southern boundary of Corackerup Nature Reserve, 34° 13' 18"S, 118° 39' 21"E, 4 Nov. 2000, *D. Nicolle* 3565 *& M.E. French* (CANB, PERTH).

Distribution and habitat. Known from a few populations in a small area of the Corackerup Creek catchment between Ongerup and Bremer Bay in Western Australia. Grows in clayey soils in undulating topography. Associated eucalypt species include *E. annulata, E. calycogona* subsp. *calycogona, E. neutra, E.conglobata* subsp .*perata* and *E. vegrandis* subsp. *vegrandis*. (Figure 6A)

Conservation status. Known from Corackerup Nature Reserve. Conservation Codes for Western Australian Flora: Priority Two.

Flowering period. September to October (Brooker and Hopper 2002).

Notes. Superficially similar to *E. platypus* subsp. *platypus*, particularly in habit, differing in the larger adult leaves, the larger buds with a hemispherical, prominently warty operculum; the red, inflexed staminal filaments and the larger, 5 to 7- valved fruits.

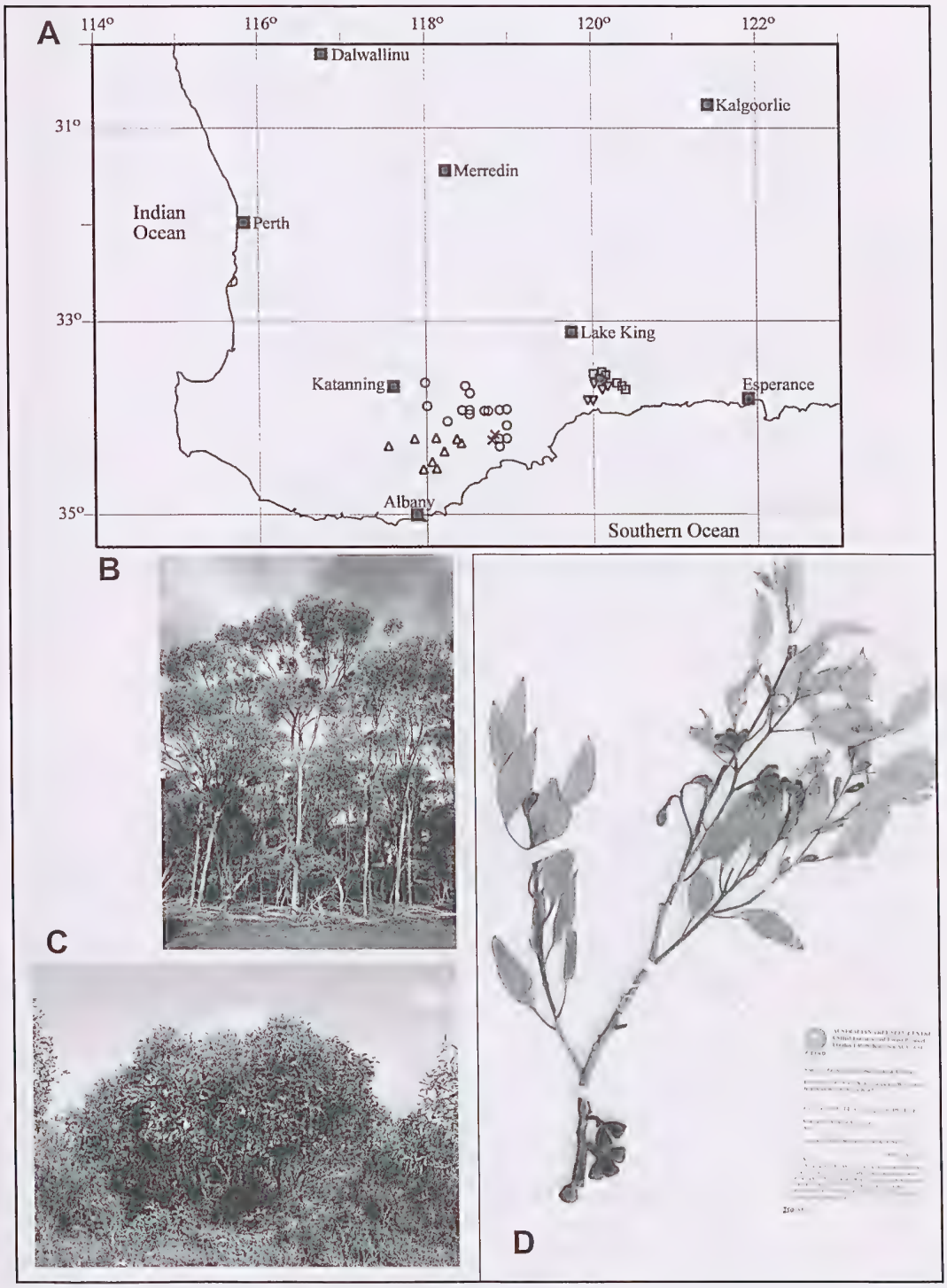

Figure 6. A – Distribution of *E. vesiculosa* ×, *E. cernua* □, *E. proxima* ▽, *E. vegrandis* subsp. *vegrandis* ○ and subsp. *recondita* △ in WA; B – Habit of *E. cernua* at type locality (4.6 km N of Ravensthorpe–Albany rd on Lake Grace rd); C – Habit of type individual of *E. proxima* (*M.I.H. Brooker* 13240 & *D. Nicolle*); D – Isotype of *E. proxima* (*M.I.H. Brooker* 13240 & *D. Nicolle*).

Appendix of hybrids and intergrades involving the *E. spathulata* complex

***E. alipes* – *E. spathulata* subsp. *salina* intergrades**
Selected specimen: 32.3 km from Kondinin towards Hyden, 32° 30' 00"S, 118° 35' 52"E, 15 July 2001, *D. Nicolle* 3811 & *M. French* (CANB, PERTH).

***E. alipes* – *E. suggrandis* subsp. *suggrandis* intergrades**
Selected specimens: 3.1 km from Neds Corner Rd on Pyramid Rd, 33° 10' 07"S, 121° 04' 07"E, 20 July 2001, *D. Nicolle* 3959, 3960 & *M. French* (CANB, PERTH).

E. proxima* × *E. suggrandis* subsp. *suggrandis
Selected specimen: 36.9 km N of Hopetoun towards Ravensthorpe, 33° 38' 16"S, 120° 09' 01"E, 5 Nov. 2000, *D. Nicolle* 3572 & *M. French* (CANB, PERTH).

E. arachnaea* subsp. *arachnaea* × *E. orthostemon
Selected specimen: NE of Calingiri, 31° 03' 51"S, 116° 29' 37"E, 13 Jan. 2001, *D. Nicolle* 3693 & *M. French* (CANB, PERTH).

E. cernua* × *E. platypus* subsp. *congregata
Selected specimen: Ca. 3 km SE of Bandalup Hill trig and 4.5 km S of Mason Bay Rd on N–S track E of Hill, 33° 39' 41"S, 120° 24' 02"E, 18 Feb. 1998, *G.F. Craig* 3617–2 (PERTH).

E. cernua* × *E. sporadica
Selected specimen: 1.7 km N of Jerdacuttup North Rd, Old Kundip townsite, 29 June 1988, *N. McQuoid* 17 (CANB, PERTH).

E. erythronema* var. *erythronema* × *E. orthostemon
Selected specimen: 0.95 miles E of Manmanning, 11 Mar. 1989, *B.H. Smith* 1158 (AD, BRI, CANB, MEL, NSW, PERTH).

E. erythronema* var. *marginata* × *E. orthostemon
Selected specimen: NE of Calingiri, 31° 03' 51"S, 116° 29' 37"E, 13 Jan. 2001, *D. Nicolle* 3692 & *M. French* (CANB, PERTH).

E. loxophleba* subsp. *loxophleba* × *E spathulata* subsp. *spathulata
Selected specimens: 0.6 km W of Eldridge Street, Ongerup, on main road, 18 May 1987, *M.I.H. Brooker* 9638 (CANB, PERTH); 5 km E of Ongerup on Gnowangerup–Jerramungup road, 3 Dec. 1999, *N. McQuoid* 550 (PERTH).

***E. orthostemon* – *E. suggrandis* subsp. *promiscua* intergrades**
Selected specimen: 22.8 km from Kondinin towards Hyden, 32° 30' 47"S, 118° 29' 58"E, 15 July 2001, *D. Nicolle* 3810 & *M. French* (CANB, PERTH).

E. orthostemon* × *E. wandoo* subsp. *wandoo
Selected specimens: 0.2 km from Johnston Rd–Nyabup Rd junction towards Tambellup, 34° 05' 58"S, 117° 35' 55"E, 10 Feb. 2001, *D. Nicolle* 3774 & *M. French* (CANB, PERTH); 2.1 km from Yonka Rd on Peter Valley Rd, N of Cranbrook, 34° 11' 01"S, 117° 30' 00"E, 10 Feb. 2001, *D. Nicolle* 3784 & *M. French* (CANB, PERTH)

***E. orthostemon* × *E. vegrandis* (subspp. *vegrandis* <–> *recondita*):**
Selected specimen: 7.4 km on Toolbrunup Rd from Great Southern Hwy, SE of Tambellup, 34° 05' 25"S, 117° 44' 45"E, 10 Feb. 2001, *D. Nicolle* 3777 & *M. French* (CANB, PERTH).

E. phaenophylla* × *E. suggrandis* subsp. *suggrandis
Selected specimen: 37.4 km N of Hopetoun towards Ravensthorpe, 33° 38' 03"S, 120° 08' 49"E, 5 Nov. 2000, *D. Nicolle* 3573 & *M. French* (CANB, PERTH).

E. platypus* subsp. *platypus* × *E spathulata* subsp. *spathulata
[Representative of the type of *E. platypus* var. *heterophylla*]
Selected specimens: 4.8 km N of Ongerup on road to Pingrup, 21 Oct. 1992, *P.J. White* 371 (PERTH); 2.3 km N of Ongerup–Jerramungup road on Ongerup–Pingrup road, 8 Apr. 1995, *M.I.H. Brooker* 12210 (AD, CANB, NSW, PERTH); 7 km N of Ongerup on North Ongerup Rd, 10 July 2000, *N. McQuoid* 556 (PERTH).

E. platypus* subsp. *platypus* × *E suggrandis* subsp. *suggrandis
Selected specimen: Twertup Field Studies Centre, ca. 35 km from junction of South Coast Hwy and Quiss Rd in Fitzgerald River National Park, 12 Mar. 1989, *S.D. Hopper* 7130 (PERTH).

E. spathulata* subsp. *spathulata* × *E. tenera
Selected specimen: 13 mls N of Pingrup on road to Lake Grace, 4 Apr. 1968, *S.G.M. Carr* 677 (PERTH).

***E. suggrandis subsp. suggrandis* – subsp. *promiscua* intergrades**
Selected specimen: 50 miles E of Ongerup, 13 Mar. 1957, *J.W. Green* 1185 (PERTH).

***E. vegrandis* subsp. *recondita* – subsp. *vegrandis* intergrades**
Selected specimen: 7.4 km on Toolbrunup Rd from Great Southern Hwy, SE of Tambellup, 34° 05' 25"S, 117° 44' 45"E, 10 Feb. 2001, *D. Nicolle* 3778 & *M. French* (CANB, PERTH).

E. vegrandis* subsp. *recondita* × *E. xanthonema
Selected specimens: c. 80 m E of firebreak & 10 m N of E–W firebreak running off E, (i.e. in the NE corner of junction of tracks), Stirling Range National Park, adjacent to caravan park, N boundary of park, 23 Nov. 1983, *S.D. Hopper* 3588, 3589, 3590 (PERTH).

Acknowledgements

The senior author is most grateful to Malcolm French for accompaniment on many 'vegrandis' field trips and general discussions about the complex, as well as welcomed hospitality in Perth. We thank Peter White (CALM) for continued input towards resolving the *E. spathulata* complex. We are grateful to CSIRO Forestry and Forest Products for financial assistance in the later part of the study.

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New taxa, a new record and a rediscovery in Western Australian *Haloragis* (Haloragaceae)

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Abstract

Orchard, A.E., Lepschi, B.J. and Hislop, M. New taxa, a new record and a rediscovery in Western Australian *Haloragis* (Haloragaceae). *Nuytsia* 15(3): 431–443 (2005). Variation and distribution in taxa of the *Haloragis gossei–H. trigonocarpa* group is discussed and two new taxa, *H. maierae* Orchard and *H. gossei* var. *inflata* Orchard are described. Rediscovery of *H. platycarpa* is noted, and an amended description of this rare species is provided. Variation in the *H. aculeata–H. scoparia* group is discussed, and a widely disjunct new record, *H. glauca* forma *glauca*, is noted for the State.

Introduction

Haloragis is a genus of 28 species, largely confined to Australia, with just four species extending to islands of the Pacific (Vanuatu, New Caledonia, New Zealand, Cook Islands, Rapa, Juan Fernandez) probably by relatively recent long-distance dispersal. The species are essentially temperate in distribution, extending into eremaean regions, but are absent from most tropical regions. Most are found on loam or clay soils, although annual eremaean species are found on sandy substrates. Two species are aquatic or subaquatic. Nowhere is *Haloragis* a dominant taxon, but in southeastern Australia some species (such as *H. aspera*, *H. glauca* and *H. heterophylla*) show weedy proclivities and are minor weeds of agriculture and horticulture.

Most eastern species are relatively widespread, and few are rare or endangered. In Western Australia the situation is somewhat different. The eremaean species are widespread and relatively common, but the temperate taxa from wetter areas are mostly very rare and scattered. This may be due in part to a scarcity of heavier soils in the better watered areas of southern WA, and in part to widespread clearing, particularly in the wheatbelt. The lack of collections may also be due to them being rather inconspicuous plants. Whatever the reason, *Haloragis* in southern WA contains a disproportionately high percentage of poorly known, poorly collected, and apparently very restricted species. This paper re-examines some of them in the light of newly available material.

Materials and Methods

This study is based on examination of selected herbarium collections from AD, CANB, MEL, NSW

and PERTH. All measurements were made from herbarium material (reconstituted where necessary). See the end of this issue for definitions of conservation codes used in this paper.

The *Haloragis gossei* complex

In previous papers (Orchard 1975, Orchard 1990) it was recognised that *Haloragis gossei* and *H. trigonocarpa* were closely allied, and formed a distinctive subgroup within the genus. They are characterised by being eremaean in distribution (most other species are temperate, from seasonally wet areas, some even being aquatic or subaquatic), they are trimerous (most other species are 4-merous, although a few are 1-, 2- or 3-merous), annual (most others are perennial), and they have well developed papery wings on the fruit, presumably to facilitate wind dispersal (in other species with winged fruits, e.g. *H. acutangula* and *H. odontocarpa*, the wings are not consistently developed, and they are thick and sub-woody, not papery).

Haloragis gossei and *H. trigonocarpa* are clearly closely related, and can only be reliably distinguished from each other by characters present in their mature fruits.

H. gossei has fruits which are usually 6.5–8 mm long and 5.5–8 mm wide (including the wings). About 3–5 main veins arise from the body of the fruit and extend into the wings to form 'struts'. These veins are obvious but not particularly woody. The islets between these main veins are covered by the papery exocarp, which is opaque. The 'struts' plus their covering have a flexible, parchment-like texture. About two thirds to three quarters of the way to the margin of the wings the main veins link to form an arching intramarginal vein. Beyond this, numerous small dichotomising veins extend almost to the margin of the wing. As the fruit develops the sepals enlarge considerably. In the mature fruit they generally bear three main veins – a central vein which runs almost to the tip of the sepal with two prominent lateral veins departing at 90° about two thirds of the way to the tip (forming a cross), and two lateral unbranched veins which usually curve gradually to the lateral corners of the sepal. The fruit in *H. gossei* is always glabrous, as is the rest of the plant.

H. trigonocarpa has much smaller fruits, usually 4.0–4.5 mm long and 2.5–3.5 mm wide (including the wings). Again, about 3–5 main veins arise from the body of the fruit and extend into the wings as 'struts'. However, the 'struts' in this species are far more woody than in *H. gossei*, making the wings rigid, rather than parchment-like as in *H. gossei*. Furthermore, the exocarp covering the 'struts' is much thinner and almost translucent, resulting in the wings appearing to have windows in them (i.e. the effect is that of the wings of a dragonfly or of many Diptera). As in *H. gossei* the main veins in the wings link to form an intra-marginal vein, but in this species this intramarginal vein is much woodier, closer to the margin, and lacks the fringe of fine dichotomising veins beyond. The sepals in *H. trigonocarpa* also increase in size with the fruit, but they bear only the trident-shaped central vein. The two lateral veins in the sepal do not develop or are insignificant. The fruit in *H. trigonocarpa* is usually glabrous, but sometimes it bears very short (0.1 mm) simple hairs on the body of the fruit, not extending to the wings. In specimens of this latter variant (e.g. *Phillips* s.n., CBG 031071) the remainder of the plant is glabrous as in *H. gossei*.

The two species overlap in distribution to some extent, although *H. gossei* tends to be more northerly and easterly, being most common in central Australia and the Pilbara/ Hamersley Range area of Western Australia (the latter an area bounded roughly by Port Hedland, Newman and North West Cape). *H. trigonocarpa* is confined to Western Australia, and is most common in the Goldfields area, but

extends in an arc to Shark Bay and the coastal area north from there to North West Cape. Outliers are known for both species beyond the above areas. The two species overlap in distribution or come close together in the Kalgoorlie–Leonora district, and in the Exmouth Gulf–North West Cape area.

1. Introgression between *H. gossei* and *H. trigonocarpa*

Given their close relationship, and a partly overlapping distribution, it is not surprising to find a number of collections in which the fruits are somewhat intermediate between *H. gossei* and *H. trigonocarpa*, suggesting a small degree of introgression or hybridisation. The fruits of these putative hybrids are generally more variable on individual plants than is the case with plants of either of the parent species, and they are usually intermediate in their characteristics. They usually measure about 5–6 mm in length and width (including wings), the main venation is usually fairly woody, but the islets are opaque, and the fringing fine dichotomous veins at the margin of the wings are usually present. Sepal venation varies from that typical of *H. gossei* to that of *H. trigonocarpa*, often on the same plant. The intermediate collections are largely confined to the margins of the Pilbara, in the main region of species overlap, but they might also be expected to be found in the Goldfields. From the variability observed it seems likely that many of these specimens represent backcrosses to one or other of the parent species, and not just F1 hybrids.

Putative hybrid specimens examined. WESTERN AUSTRALIA: 26 km S of Mt Newman turnoff on Great Northern Highway, 11 Sept. 1978, *A.C.Beauglehole* 59353 & *E.G.Errey* 3053 (PERTH); 4 km N of Nullagine P.O. on Great Northern Highway, 5 Aug. 1974, *G.W.Carr* 4650 & *A.C.Beauglehole* 48428 (PERTH); 10 mls [16 km] S of Onslow, 28 Aug. 1960, *A.S.George* 1144 (PERTH); About 5 km N of Munjina roadhouse on Newman road, 3 Sept. 1995, *A.A.Mitchell* PRP592 (PERTH); About 10 km E of Munjina roadhouse on Roy Hill road, 3 Sept. 1995, *H.J.R.Pringle* PRP587 (PERTH); Little Sandy Desert, W apron of Cooma Well, 16 Apr 1997, *S. van Leeuwin* 3098 (CANB, KARR., PERTH).

Distribution. Confined to Western Australia at the western and eastern margins of the Pilbara, and may be expected to be found in the Kalgoorlie–Leonora area of the Goldfields.

Habitat. Most specimens lack information on habitat. *Mitchell* PRP592 was described as infrequent in *Acacia distans* tall shrubland. *Pringle* PRP587 was described as infrequent in *Triodia lanigera* hummock grassland on a colluvial slope from ironstone ranges. These sparse notes suggest that the intermediate plants, like their parent species, are opportunistic annual colonisers, not particular about substrate or position.

Phenology. Flowering occurs in August and fruits develop very quickly, being apparently fully mature in September. A substantial proportion of the fruits bear apparently normal, viable seed.

2. A new species: *Haloragis maierae*

In previous papers (Orchard 1975, Orchard 1990) passing reference was made to occasional 4-merous specimens of both *H. gossei* and *H. trigonocarpa*. Additional good quality 4-merous specimens from this complex are now known, and it is clear that an additional species is involved. This species shares the annual life-form of *H. gossei* and *H. trigonocarpa*, their more or less glabrous habit, and their eremaean distribution. Superficially it resembles these two species, but on close examination is clearly distinct in its 4-merous flowers and fruits. In this respect it forms a link between the *H. gossei* complex and the core species of the genus. The new species is described below:

Haloragis maierae Orchard *sp. nov.*

Species *H. gossei* et *H. trigonocarpam* similis. Herba annua (10–) 20–30 cm alta, glabra vel pilis sparsis (vel initio densis) unicellulosis in partibus juvenibus. Flores et fructi 4-meri. Fructus 4-alatus, pallido-flavovirens, venis fuscatis, 6–7 mm longus, 5–6 mm latus; alae ad basim rotundatae, versus apicem dilatatae, truncatae sed lobo apicalo triangularo plusminusve acuto, areis intercostalibus papyraceis sed opacis. Alae venis principalibus 3-4, ex corpore fructus arcuatis, 'pluteis' formantibus. Sepala in fructus expansa; venae laterales curvatae, indivisae; vena mediana versus apicem trifida.

Typus: About 25 km SSW of Hamersley Station Homestead, 5 June 1994, *A.A. Mitchell* 3620 (*holo*: PERTH 04055322; *iso*: CANB; KARR. *n.v.*)

Annual *herb* (10–) 20–30 cm tall, glabrous, or with sparse (or initially dense) minute (<0.1 mm) unicellular hairs on young parts, soon glabrescent. *Stems* erect, branched mainly at base, terete or faintly ribbed. *Leaves* alternate (basal pair subopposite), somewhat fleshy, linear to narrowly ovate, 17–30 mm long, 2.0–2.5 (–6.0) mm wide, margins ± entire or with (0–) 1–3 widely spaced forward-pointing triangular teeth 0.3–0.5 (–1.0) mm long on each side; tip acute; lamina tapering gradually to base to form a 'petiole' c. 3.5–5.0 mm long; midrib faintly visible in dried specimens, other veins obscure. *Bracts* green, leaf-like, reduced, virtually absent in upper part of inflorescence. *Bracteoles* straw-coloured, linear, 0.5 mm long, entire or with a few minute hair-like teeth. *Flowers* in 3s in axils of bracts, 4-merous. *Sepals* 4, ovate, with a small callus at base, persistent and increasing greatly in size in fruit. *Petals* 4, strongly hooded, *c.* 1–1.2 mm long, yellowish to reddish. *Stamens* 8, filaments *c.* 0.3 mm long; anthers yellow, shortly oblong, 0.7–0.8 mm long, non-apiculate. *Styles* 4, *c.* 0.5 mm long; stigmas capitate, sparsely fimbriate. *Ovary* 4-angled, 4-locular. *Fruit* pale yellowish green with prominent darker veins, 4-winged, 6–7 mm long, 5–6 mm wide; intercostal areas papery but opaque. Wings rounded at base, gradually increasing in width towards apex, apex shortly apiculate; venation very obvious, of 3 or 4 major lateral veins arising from the body of the fruit and extending two-thirds to three-quarters of the way to the margin before dividing into numerous smaller veins, intra-marginal vein absent. Major lateral veins arching out (away from) the body of the fruit to form 'shelves'. Fruiting sepals persistent, broadly ovate, 1.7–2.0 mm long, 2–2.5 mm wide, strongly 3-veined in lower half; lateral veins undivided and diverging to margins, rarely very faint; central vein trifid towards tip; sepals incurved over a well-like hollow at apex of fruit. Seeds 1 per locule. (Figure 1A–B)

Other specimens examined. WESTERN AUSTRALIA: 22 km NW of Mt Tom Price, 16 June 1970, *B.G. Briggs* 3622, (NSW); Near Kalgoorlie, Apr. 1925, *W.H. Halford s.n.* (PERTH); Hamersley Iron's 'Silvergrass' lease, c. 70 km NW of Tom Price, 29 Aug. 1998, *M. Maier s.n.* (CANB); Wanna Munna Flats area, c. 9 km NNE of Giles & 63 km WNW of Newman, 19 Oct. 2003, *M. Maier & K. McCreery* 547 (CANB, KARR., PERTH); *loc. cit.* but 68 km WNW of Mt Newman, 23 Oct. 2003, *M. Maier & K. McCreery* 548 (PERTH); Murrin Murrin, Leonora, Goldfields, 16 Aug. 1995, *D. True* A 3.34 (PERTH); Barlee Range Nature reserve, 10.8 km W of Mt Palgrave, 7 Aug. 1993, *S. van Leeuwen* 1434, (PERTH); Little Sandy Desert, 28.7 km NE of Kulonoski East Well, 23 Oct 1996, *S. van Leeuwen* 2975 (CANB, KARR., PERTH); Munjina Claypan, Juna Downs Station, 14.6 km S of Mt Lockyer, Hamersley Range, 15 Sep. 1998, *S. van Leeuwen* 3895 (CANB, KARR. *n.v.*, PERTH); West Angelas area, 22.6 km SSE of Mt Meharry, Hamersley Range, 16 Sep. 1998, *S. van Leeuwen* 3975 (CANB, KARR. *n.v.*, PERTH); West Angelas area, upper reaches of Turee Creek East Branch, 4.3 km E of West Angela Hill, Hamersley Range, 19 July 2000, *S. van Leeuwen* 4754 (CANB, KARR. *n.v.*, PERTH); Newman, *s. dat., K. Walker s.n.* (PERTH).

Distribution. Confined to inland Western Australia, where it is found discontinuously in an arc from the Hamersley Range through Leonora to the vicinity of Kalgoorlie. An additional specimen (*Nelson* 2384;

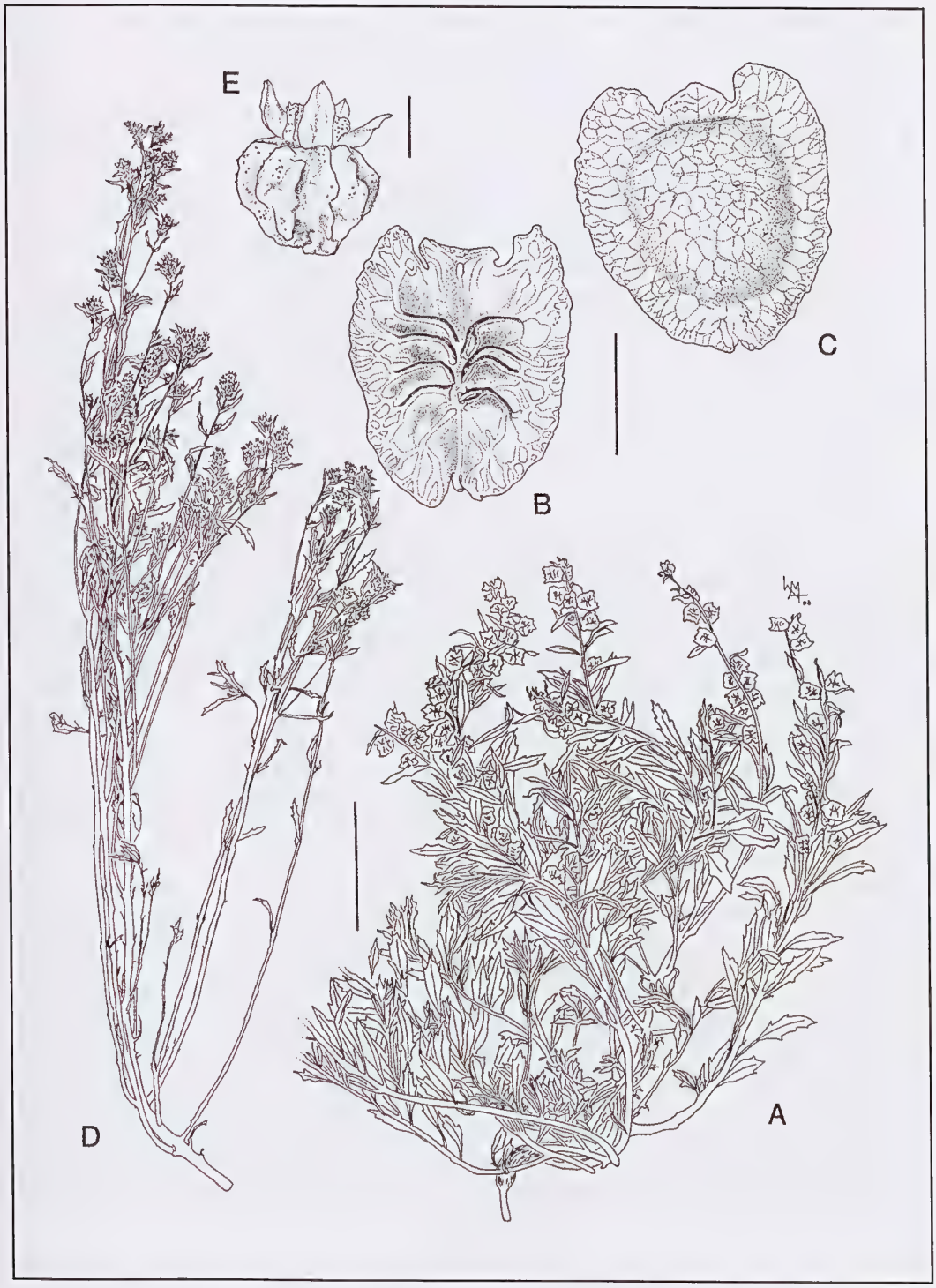

Figure 1. A–B. *Haloragis maierae*. A – habit, B – fruit; C. *Haloragis gossei* var. *inflata* fruit; D–E. *Haloragis platycarpa*. D – habit, E – fruit. Drawn from *Mitchell* 3620 (A–B), *A.S. George* 10218 (C) and *Hislop* 2134 (D–E). Scale bars: A & D – 4 cm; B & C – 3 mm; E – 1 mm.

CANB; AD, DNA *n.v.*) from Hamilton Downs Station in the southern Northern Territory probably also belongs to this taxon, although the prominent lateral veins in the fruit are not well developed. In all other respects the specimen is a good match for *H. maierae*. (Figure 2)

Habitat. In the Pilbara region, *H. maierae* has been recorded from grassland-herbfield communities, often with scattered emergent *Acacia* spp. (*Mitchell* 3620, *van Leeuwen* 3895, 3975), open *Acacia* spp. scrub with a variously developed understorey of shrubs, grasses and herbs (*van Leeuwen* 1434, 4754), clayey plain in *Eriachne benthamii* tussock grassland (*Maier & McCreery* 547), gilgai within a clayey plain, in mixed tussock grassland with *Aristida latifolia*, *Astrebla* sp. and *Eragrostis setifolia* (*Maier & McCreery* 548), open scrub of *Melaleuca* sp., over heath-low scrub of *Halosarcia* spp., over dwarf scrub of Goodeniaceae spp., over open herbs of *Zygophyllum* sp. and *Sclerolaena* sp. (*van Leeuwen* 2975), and open *Senna hamersleyensis* / *Eremophila maculata* shrubland over dense herbland (*Maier s.n.*). The single goldfields collection with habitat data (*True* A 3.34), records *H. maierae* as associated with *Acacia aneura*, *Pogonolepis stricta* and *Haloragis gossei*. In all instances soil types are either clay or clay-loam, except *van Leeuwen* 2975, which was recorded from loamy red brown sand over calcrete-gypsum at depth. The Northern Territory collection (*Nelson* 2384) was recorded from a chalcedony rise with *Triodia clelandii*.

Phenology. It is likely that flowering and fruiting in this species are opportunistic, depending on local rainfall to trigger germination and quickly complete its annual life cycle. The transition from flowering to fruiting seems to be rapid, with all stages present on a number of the specimens examined. Flowers are present on plants collected between June and September, and fruits on specimens collected in April and June through to September in Western Australia. The *Nelson* 2384 collection from the Northern Territory was flowering and fruiting in November. *Van Leeuwen* 1434 and *Briggs* 3622 represent very young, unbranched seedlings bearing no more than 10–12 leaves, but already flowering and bearing young fruit.

Affinities. Clearly allied to the *H. gossei–H.trigonocarpa* complex, sharing their annual life-form, soft (somewhat fleshy) glabrous texture of stems and leaves, and distinctly winged fruits. It forms a link between those species (which are 3-merous) and the 4-merous species which are at the core of the genus.

This species is distinguished from *H. gossei* and *H. trigonocarpa* by the hairs on very young stems and leaves, by the 4-winged fruits, and by the bizarre venation of the fruits. In these two species the 3–4 main veins running from the body of the fruit into the wings are flattened against the body of the fruit. Within the wings they form large lacunae before anastomosing and breaking up into numerous finer, radiating veins in the margin of the wings. In *H. gossei* the lacunae are opaque. In *H. trigonocarpa* the main veins are much more woody than in *H. gossei*, and the lacunae in the wings are almost transparent. In *H. maierae* the main veins from the body of the fruit begin by projecting outwards almost at right angles, before arching back into the wings. In doing this they stretch the papery exocarp over their basket-like framework, forming a series of 'shelves' between the wings. The arching main veins are very distinct in northern WA collections, but less pronounced in southern WA collections from near Leonora and Kalgoorlie. These southern collections also have less obvious lateral veins on the fruiting sepals. In *H. maierae* the lacunae are opaque, as in *H. gossei*. In fruit size, *H. maierae* is intermediate between the other two species.

Two specimens of undoubted *H. gossei* (3-winged fruits) are known in which the major veins are slightly arching, and thus resemble *H. maierae*. They are *T.J.Fatchen* 970 & 982 (both AD), both collected from the Great Sandy Desert at 19° 20' S, 125° 23' E. The first was growing on a sandridge crest, the second

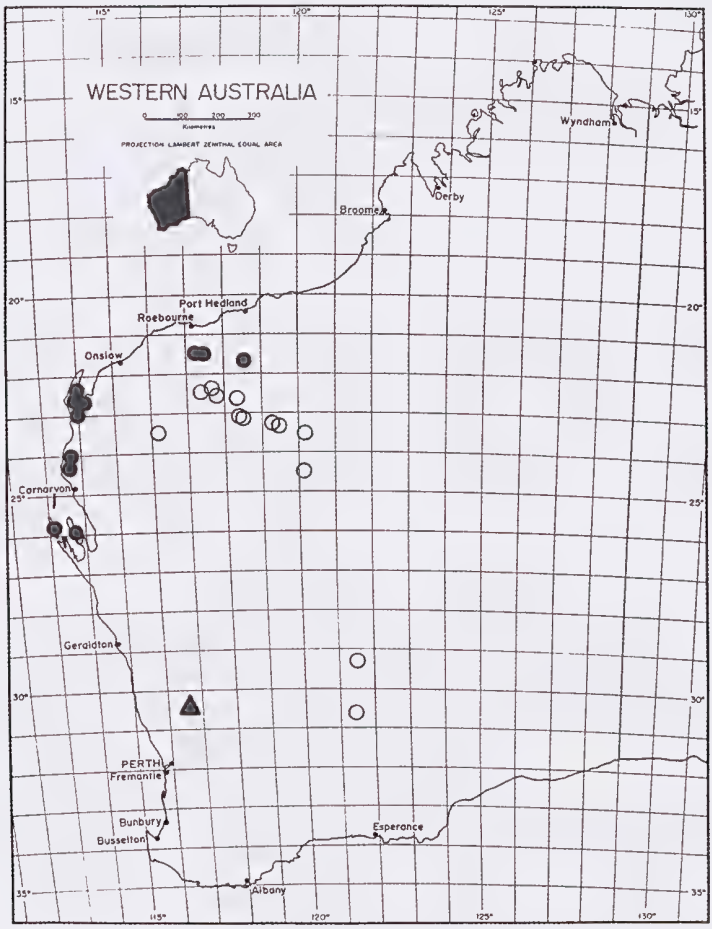

Figure 2. Distribution of *Haloragis gossei* var. *inflata* ●, *H. maierae* ○ and *H. platycarpa* ▲.

on the edge of a large termite mound in a damp depression. They are the only specimens that suggest the possibility of introgression between *H. gossei* and *H. maierae*.

Conservation status. The species is known from only a small number of collections, but these are spread across a very wide area. Superficially the species resembles *H. gossei* and *H. trigonocarpa*, and is more or less sympatric with both. It is likely that with careful examination of '*H. gossei*' populations *H. maierae* will be found to be much more common than is presently indicated. It is conserved at least within the Barlee Range Nature Reserve.

Etymology. Named for Ms Michi Maier, who first drew my attention to the species, collecting material north of Laverton.

Notes. In Orchard (1975) attention was drawn to an abnormal form of *H. gossei* from Maralinga in which some fruits were 4-winged and 2-locular. Another specimen (*H. Turner s.n.* (AD97604592)) is now known from the same area, and has the same general characteristics, although the 4-winged fruits seem to be 4-locular, not 2-locular. In both plants the majority of the fruits are typical for *H. gossei*, and the abnormal fruits are found sporadically in the inflorescence (perhaps 1 in 50). This unstable characteristic combined with other vegetative differences noted in Orchard (1975), and the locality, suggest that this might be a case of radiation-induced mutation (Maralinga was the site of several nuclear tests in the mid-20th century). In any case, they do not represent an outlier of *H. maierae*.

3. Inflated-fruit forms of *H. gossei*

In Orchard (1975) it was noted that some species in Haloragaceae develop an inflated exocarp. This phenomenon is of unknown significance. It seems to be unrelated to disease, but may provide additional buoyancy to the fruits for wind or water dispersal. It is ubiquitous in *Haloragis uncatipila*, which is clearly related to *H. aspera*, *H. glauca* and *H. dura*, all of which have uninflated fruits. *H. platycarpa* demonstrates the same phenomenon, but less markedly (see below). In *Glischrocaryon* a single species, *G. roei* has consistently swollen fruits; those of other species are usually uninflated (although occasional more or less inflated fruits are known in *G. aureum*). Similarly, in *Haloragodendron*, *H. baeuerlenii* has consistently inflated fruits, *H. glandulosum* has slightly inflated fruits, and the fruits of the other three species are uninflated.

In *Haloragis gossei* a slightly different process is occurring. In normal plants the body of the fruit is dry and crustaceous, with parchment-like wings arising, as previous described. At the base of each wing there is often a very small amount of spongy tissue which provides a semi-rigid base for the wings. However, in a small number of specimens the fruit develops a large amount of puffy inflated tissue over the body of the fruit, and this inflated tissue extends into the wings. The fruit becomes almost globular, with just rudimentary wings protruding at the margins. The venation of the exocarp also changes. Instead of 3–5 main veins extending as 'struts' into the wings, the exocarp venation becomes a reticulum of fine veins, giving the fruit a bizarrely different appearance.

Haloragis gossei var. inflata Orchard, *var. nov.*

A *H. gossei* var. *gossei* fructu differt: exocarpium in corpu fructus valde inflatum, mesocarpio spongioso; exocarpium venis tenuibus reticulatum.

Typus: 23 miles S of Learmonth, 29 Aug. 1960, *A.S. George* 1255 (*holo*: PERTH 03495930).

Very similar to *H. gossei* var. *gossei*, but differing in its fruits. Exocarp on body of fruit grossly inflated; mesocarp spongy; exocarp with fine reticulate venation (Figure 1C). See Orchard (1990) for illustrations of *H. gossei* var. *gossei* and Orchard (1975) for illustrations of that taxon and *H. trigonocarpa*.

Other specimens examined. WESTERN AUSTRALIA: 13 miles [c. 21 km] S of Bullara turnoff, 3 Nov. 1973, *H. Demarz* 4824 (PERTH); Dirk Hartog Island, Sept. 1972, *A.S. George s.n.* (PERTH); 116 miles [c. 186 km] S of Port Hedland, 26 Aug. 1960, *A.S. George* 1089 (PERTH); 20 miles [c. 32 km] S of Learmonth, 5 Aug. 1967, *A.S. George* 9172 (PERTH); 10 miles [c. 16 km] N of Quobba HS, N of Carnarvon, 3 Sept. 1970, *A.S. George* 10169 (PERTH); 25 miles [c. 40 km] N of Cardabia HS, N of Carnarvon, 4 Sept. 1970, *A.S. George* 10218 (PERTH); 7.25 km E of Cape Cuvier, N of Carnarvon, 25 Aug. 1995, *G.J. Keighery & N. Gibson* 902 (PERTH); Denham, 26 Sept. 1992, *M. Lewis* 21/92 (PERTH); Millstream Creek crossing, Watersupply

Road, Millstream area, 19 June 1990, *E.Leyland* MC 035 (PERTH); Summit Tanks, Millstream, Millstream-Chichester NP, 19 June 1990, *E.Leyland s.n.* (PERTH); Osprey Bay, 26 Aug. 1992, *E.Leyland* EL68 (PERTH); Learmonth, 17 Oct. 1964, *J.Thompson s.n.* (PERTH).

Distribution. Confined to Western Australia, mainly from near-coastal sites from Denham and Dirk Hartog Island (Shark Bay area) north to Learmonth, Exmouth Gulf. Three inland collections are known, two from Millstream–Chichester National Park, and the other from south of Port Hedland. (Figure 2)

Habitat. Most collections have been made very close to the sea, but only limited habitat information is recorded. *Lewis* 21/92 was found in brown sand near a track to the sea; *Keighery & Gibson* 902 was from a broad flat between dunes in red sand over limestone.

Phenology. Flowering and fruiting has been recorded from June to September.

Conservation status. No information is available on local abundance, but the variety is widespread, and not subject to any obvious threat. It is conserved in Millstream–Chichester National Park.

Rediscovery of *Haloragis platycarpa*

This species was described by Bentham in 1864 from a Drummond collection (1st Coll. No. 705) from the 'Swan River district' of Western Australia. Orchard (1990) considered it to be possibly extinct, as it had not been rediscovered for nearly 150 years. A small remnant population has now been found near Dalwallinu, Western Australia, and an amended description has been prepared.

Haloragis platycarpa Benth., *Fl. Austral.* 2: 478 (1864)

Illustrations. Schindler, *Pflanzenr.*, 23: 13L–N (1905); Blackall & Grieve, *How To Know West. Austr. Wildfl.*, 3: 469 (1965).

Sprawling, much branched ?perennial *herb* 30–40 cm, with vegetative parts glabrous except for scattered, papillose hairs 0.1–0.2 mm long on the stems. *Branchlets* 4–5 ribbed, angular–terete, becoming more or less terete with age, green, ageing reddish. *Leaves* alternate to subopposite (predominantly alternate in upper portion of plant), sessile, narrowly to very narrowly elliptic or narrowly to very-narrowly obovate, (10–) 15–45 mm long, 2–5 (–10) mm wide; base attenuate; apex acute; margin with (1–) 3–5 teeth in distal *c.* 2/3; teeth triangular to narrowly triangular, sometimes incurved, 1–3 mm long. *Inflorescence* an indeterminate spike of 1–3 -flowered dichasia in the axils of the primary bracts. Auxillary inflorescences borne in the axils of the upper leaves. Only the central flower of the dichasium is functional. Primary *bracts* leaf-like, narrowly to very narrowly elliptic, 8–10 mm long, 1–2 mm wide; base attenuate; apex acute; margin with (0–) 1–2 teeth in distal *c.* 2/3 to 1/2; teeth triangular to narrowly triangular, sometimes incurved, 0.1–0.4 mm long. Secondary *bracts* herbaceous, with a broad scarious margin, concave, elliptic to narrowly elliptic, 0.9–1.1 mm long, 0.2–0.3 mm wide; margin with 0–3 vestigial teeth. Tertiary *bracts* scarious, concave, narrrowly to very narrowly ovate, 0.3–0.5 mm long, 0.1–0.15 mm wide; margin entire. *Flowers* 4-merous, pedicellate; pedicel 0.2–0.3 mm long in flower and fruit. *Sepals* 4, ovate to broadly ovate, 0.6–0.8 mm long, 0.4–0.5 mm wide, minutely papillose abaxially and on margins, persistent to fruiting stage. *Petals* 4, herbaceous, with a broad scarious margin, hooded, concave and keeled, narrowly oblong, 1.6–2 mm long, 0.5–0.6 mm wide, glabrous or (more usually) minutely papillose on keel. *Stamens* 8; filaments 0.2 mm long; anthers yellow, non-apiculate, narrowly oblong, 1.4–1.5 mm

long, 0.3–0.4 mm wide. *Styles* 4, narrowly ovoid, minutely papillate (especially proximally); stigmas capitate. *Ovary* depressed pyriform to depressed globular, 0.4–0.6 mm long, 0.8 mm wide, not ribbed, densely minutely papillose, 4-locular. *Fruits* 1 per axil, depressed globose, 1.7–2.5 mm long, 2.2–4 mm wide, 4-locular, weakly 8-ribbed, especially distally, appearing more or less rugose overall, densely minutely papillose; endocarp and septa woody; exocarp swollen, more or less spongy. (Figure 1D–E)

Specimens examined. WESTERN AUSTRALIA: W.A., *s. dat.*, *J. Drummond* 1: 705 (MEL 39217, 39218, 39219); Dalwallinu [precise locality withheld for conservation purposes], 6 Oct. 2000, *M. Hislop* 2134 (CANB, PERTH).

Distribution. Known only from the environs of Dalwallinu, in the Avon Botanical District of south-western Western Australia. None of the Drummond collections have accurate locality data (cf. Orchard 1975). (Figure 2)

Habitat. Hislop 2134 was found growing in bare brown loam in low woodland of *Acacia acuminata* with *Grevillea levis* and *Pimelea avonensis*.

Phenology. Hislop 2134, collected in early October, is in young flower. Plants from the same population were in mature fruit in late November. Drummond's collections are undated except as to year.

Affinities. H. platycarpa seems to have no very close relatives. It belongs to that fairly generalised group of species which in Western Australia includes *H. scoparia*, *H. hamata* and *H. foliosa*, but differs from all of these in its small fruit with somewhat inflated pericarp and densely papillose indumentum. In its inflated pericarp it resembles *H. uncatipila* from central Australia, but that species is larger in all its parts, including the fruit, and the indumentum is of hooked rather than short papillose hairs. The resemblance is more likely to be attributable to convergence than to a true relationship.

Conservation status. Conservation Codes for the Western Australian Flora: Declared Rare Flora. Presently known from only one population (*Hislop* 2134). Further fieldwork is required to determine whether any additional populations exist.

Haloragis foliosa

Haloragis foliosa, once one of those species of the coastal plain known only from original and inadequate material (Orchard, 1976, 1977), is now relatively well represented in collections, although all specimens are from a relatively restricted area between Dongara, Eneabba and the coast. It seems, like many *Haloragis* species, to be favoured by disturbed habitats, and is frequently collected from scraped areas on road shoulders. It can be distinguished from *H. scoparia* and *H. aculeolata* by its 4-locular ovary and fruit. Specimens additional to those previously reported are cited below:

Specimens examined. WESTERN AUSTRALIA: Southern Beekeepers Reserve (Reserve 36053), ENE of Cervantes, 29 Oct. 1991, *E.A. Griffin* 6655 (PERTH); Remote part of Beekeepers Nature Reserve 24496 near the western end of the Mt Adams Road, 10 Jan. 1995, *R.P. Hart* 2440 & *D. Corbyn* (CANB, PERTH); Bay of Plenty, N of Leeman, 5 Dec. 1994, *G.J. Keighery* 13198 (PERTH); 15.75 km N of Coolimba–Eneabba Road on coastal road, 30 Apr. 1992, *S.J. Patrick* 1043 (PERTH); Cliff Head Road, 10.8 km S of intersection with Brand Highway, 6 Jan. 1992, *S.J. Patrick* 935 & *A.P. Brown* (PERTH).

Distribution. Confined to heaths between Dongara, Enneaba and the coast.

Habitat. Most collections are described as growing in shallow white, yellow or grey sand over limestone. Several were from scraped soil on road shoulders. Associated species include *Acacia rostellifera*, *Melaleuca* sp., *Anthocercis littorea*, *Santalum acuminatum*, *Melaleuca huegelii*, *Beyeria* sp., *Trymalium* sp., *Salsola kali*, *Thryptomene* sp., *Lomandra maritima*, *Melaleuca systena* and *Loxocarya flexuosa*.

Phenology. Specimens have been collected in flower in October to December, and in fruit in January to April.

Conservation status. Population sizes range from 7 to 200+ individuals. Several populations are in Nature Reserves. Conservation Codes for the Western Australian Flora: Priority Three.

Haloragis aculeolata and Haloragis scoparia

In earlier papers (Orchard 1975; Orchard 1990) the status of the two species *H. aculeolata* and *H. scoparia* was indicated to be uncertain. Both were known from their type collections and from very few, rather scrappy, other collections. All material was 50 or more years old, and there appeared to be the possibility that the two taxa were extinct. They were distinguished principally by indumentum characters.

Since 1990, although a few collections have been made, adequate material for a re-evaluation of the species has proven frustratingly elusive. One hypothesis to be tested was that the two taxa only represented extreme forms of a single variable species, ranging from glabrous to scabrous plants, and with ovaries and fruits ranging from 1–4 locules. This is still possible. However, re-examination of previous collections, together with a small number of new specimens, has provided better characters for their separation, and it is proposed here that the species be maintained.

The degree of scabridity is now considered inadequate to distinguish the two species, but they do differ markedly in their sepals. *H. scoparia* has ±cordate sepals, about as long as wide, with a fringe of coarse scabrid hairs on the margin (sometimes rather sparse). In *H. aculeolata* the sepals are deltoid to narrowly deltoid, usually longer than broad, and lack the marginal hairs. The number of locules seems to be variable, with new material of *H. scoparia* having 2-locular ovaries and fruit, and that of *H. aculeolata* 1-locular or 3-locular fruits. The fruits of *H. aculeolata* are borne in clusters of (1–) 3–7 in the axils of the bracts, not singly as previously reported. New material of the two taxa is detailed below.

Haloragis scoparia Fenzl

Specimens examined. WESTERN AUSTRALIA: without definite locality, 1854, *J.Drummond* 82 (PERTH); Ellis Road, Yalgorup National Park, 9 Apr 1994, *G.J.Keighery* 13023 (PERTH); Cannington, 26 Dec 1901, *A.Morrison s.n.* (PERTH) – the last previously included in *H. aculeolata*.

Distribution. Known definitely only from Cannington (eastern suburbs of Perth) and the Yalgorup National Park, south of Mandurah, both on the Swan Coastal Plain.

Habitat. This appears to be a plant of wetter areas. No details of habitat are known for the Cannington

collection, although it may have been from swampy or riverine habitats. Habitat details for *Keighery* 13023 are: "old lake bed; winter wet. *Eucalyptus rudis* over *Melaleuca polygaloides* [= *M. incana*] shrubland. Black calcareous clay over limestone."

Phenology. Flowers are known in December and April; fruits have yet to be collected on a fully dated specimen.

Conservation status. In Yalgorup National Park the species is described as "common throughout the area". However, this is the only known recent collection of the species. Conservation Codes for the Western Australian Flora: Priority One.

Haloragis aculeolata Benth.

Specimens examined. WESTERN AUSTRALIA: 25 km E of North Bannister, 5 Dec. 1996, *R.Davis* 1613 (PERTH); Lake Preston, northern end, on road to Preston Beach, Yalgorup National Park, 16 Mar. 1989, *G.J.Keighery* 11375 (PERTH).

Distribution. This species is known from only three definite localities, widely scattered in south-western Western Australia: at Lake Preston on the Perth Coastal Plain, at North Bannister, west of Pingelly on the plateau of the Darling Range, and at Toolbrunup in the Stirling Range. The *Morrison s.n.* collection from Cannington previously assigned to this species (Orchard, 1975, 1990) is now considered to be *H. scoparia*.

Habitat. Label data for *Keighery* 11375 states: "*Eucalyptus gomphocephala* tall open woodland. Valley. Black coarse shelly sand over limestone.", while *Davis* 1613 records: "Valley, ridge. Wetland. Littered gravelly brown sandy clay over granite. Woodland."

Phenology. Fruiting collections have been recorded from December to March.

Conservation status. At the North Bannister site the species was described as abundant. Further targetted collecting is required to resolve the wide disjunctions in the known distribution and to provide information on abundance and conservation status. Conservation Codes for the Western Australian Flora: Priority Two.

***Haloragis glauca* Lindl. forma *glauca* new for Western Australia**

Haloragis glauca, formerly recorded only for the Northern Territory, Queensland, New South Wales and north-western Victoria (Orchard 1975, 1990) has now been collected in Western Australia, from Fitzgerald River National Park on the south coast of the State. Both collections were from winter-wet, summer-dry swamps, similar habitats to those recorded for many eastern populations. This locality is far removed from other populations of the species, the nearest being 2000 km away in north-western Victoria and western New South Wales. Do they represent relict populations or are they introductions? The two WA collections are somewhat variable in flower and foliage characteristics, one having a scabrous ovary/young fruit, the other having a glabrous ovary. In both the bracteoles are 1–1.3 mm long, somewhat longer than those in eastern populations (0.7–0.8 mm), and the sepals are deltoid, about as long as wide, while in most eastern populations the sepals are somewhat longer than wide. The young fruits are ±globular, one of the forms present in eastern plants. Eastern populations vary widely in their

character states, as might be expected from such a widespread taxon that perennates at least in part vegetatively. If these populations had been discovered in eastern Australia, they would have been considered as just another minor variation on the pattern exhibited by *H. glauca* forma *glauca*, and for that reason, their slightly anomalous set of characters is here not deemed sufficient to recognise the Western Australian population as taxonomically distinct. On balance, it seems most likely that this population has been isolated from those in the east for some time, but is not distinct enough to be recognised as a separate taxon. Whether it is a natural relict, or the result of long-distance (non-human) dispersal is not clear, but it should be treated as a native species in Western Australia.

Specimens examined (all PERTH). WESTERN AUSTRALIA: Quiss Swamp, Fitzgerald River National Park, 21 Nov. 1986, *K.R.Newbey* 11411; Fitzgerald River National Park, 15 Dec. 1986, *K.R.Newbey* 11420.

Distribution. In Western Australia known only from Fitzgerald River National Park. Otherwise distributed widely in drier parts of the Northern Territory, Queensland, New South Wales and Victoria.

Habitat. Habitat notes in the two collections are similar: *Newbey* 11411 was from "Floor of swamp that rarely fills with water; grey clay loam. Low woodland of *Eucalyptus occidentalis*." *Newbey* 11420 was from "swamp on gently undulating plain, winter-wet/summer-dry sandy loam. *E. occidentalis*" where it was described as a "colonial semi-woody plant dying off during late summer".

Phenology. Flowers are present in November and December, young fruits in mid-December.

Affinities. Part of the *Haloragis aspera/H.heterophylla* complex, low semi-woody perennials perennating by deep rhizomatous rootstocks.

Conservation status. In Western Australia all plants are conserved within a national park. In eastern Australia, this species is widespread and common, and in some areas is even considered a weed of cultivation.

Acknowledgements

Tony Orchard thanks Michi Maier for drawing to his attention the unusual plant that now bears her name, and for her patience in waiting for him to finally write it up, and Annette Wilson for editorial polishing of the manuscript. All authors are grateful to William Murray for the illustrations, and the curators of the Western Australian Herbarium, State Herbarium of South Australia, National Herbarium of New South Wales, National Herbarium of Victoria and Australian National Herbarium, for access to their collections.

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A taxonomic review of *Dicrastylis* sect. *Corymbosae* (Lamiaceae: Chloantheae), incorporating *Mallophora* as a new synonym

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Abstract

Rye, B.L. A taxonomic review of *Dicrastylis* sect. *Corymbosae* (Lamiaceae: Chloantheae), incorporating *Mallophora* as a new synonym. *Nuytsia* 15(3): 445–455 (2005). Following a recent recommendation to conserve the name *Dicrastylis* Drumm. ex Harv. over *Mallophora* Endl., the two species previously included in the latter genus are here transferred to *Dicrastylis* sect. *Corymbosae* Munir. To achieve this, two new combinations, *Dicrastylis globiflora* (Endl.) Rye and *D. rugosifolia* (Munir) Rye, are made. The circumscription of *Dicrastylis* sect. *Corymbosae* is further altered by the removal of *D. nicholasii* F. Muell., and *D. glauca* is reduced to a synonym of *D. corymbosa*. A review of the section is presented. It is now comprised of five white-flowered species with cymes condensed into corymbosely arranged clusters, and is restricted to the south-west of Western Australia.

Introduction

In his revision of Chloanthaceae tribe Physopsidae, which is now regarded as part of Lamiaceae tribe Chloantheae, Munir (1978) divided the largest genus *Dicrastylis* Drumm. ex Harv. into five sections. Two of these sections are restricted to the south-west of Australia whereas the others are more widespread and predominantly in the arid zone. One of the south-western sections, *Dicrastylis* sect. *Dicrastylis* has recently been revised (Rye & Trudgen 1998). The other south-western group, *Dicrastylis* sect. *Corymbosae*, is reviewed here.

As envisaged by Munir (1978), *Dicrastylis* sect. *Corymbosae* consisted of the five species *D. corymbosa*, *D. glauca*, *D. nicholasii*, *D. reticulata* and *D. velutina*. One of these, the type species, *Dicrastylis corymbosa*, had originally been described under the older generic name *Mallophora* Endl. Bentham (1870) had already reduced the circumscription of *Mallophora* to a single species, *M. globiflora*, with 4-merous flowers. Munir (*loc. cit.*) maintained this circumscription but added a second 4-merous species, the newly described *M. rugosifolia*.

Recent studies (Munir 1991, Cantino 1992, Rye 1996 and Olmstead *et al.* 1999) have shed doubt on the separation of *Mallophora* from *Dicrastylis*, as discussed in Rye (2000), where it was proposed to unite the two genera by conserving *Dicrastylis* against the older name *Mallophora*. To have followed the normal rule of priority would have required many recombinations from the much more widely applied

and better known genus *Dicrastylis* to *Mallophora*. This would have been difficult to implement in view of the confused taxonomy in several species groups of *Dicrastylis* occurring in the arid zone, as these all need further study to determine how many taxa should be recognised. The proposal to conserve *Dicrastylis* has now been recommended by the Committee for Spermatophyta (Brummitt 2002: 796).

In the current review, *Dicrastylis* sect. *Corymbosae* still comprises five species, but not exactly the same five as recognised by Munir (1978). *D. nicholasii* is removed from this section and *D. glauca* is treated as a variant of *D. corymbosa*, reducing the original list to three species. The number of species recognised in section *Corymbosae* is restored to five by including *Mallophora globifera* and *M. rugosifolia* and by making the necessary recombinations to transfer them to *Dicrastylis*.

Methods

Since all of the taxa treated here have been revised by Munir (1978), new descriptions are not provided except for some additional information regarding plant height, the numbers of floral parts, distribution, habitat and flowering time. All recent collections, or a selection of them when numerous, are cited. Collections cited by Munir are not listed here unless their identification has recently been altered.

New distribution maps are provided incorporating the data from new collections and excluding any previously mapped localities that appear to be vague or inaccurate. They have been plotted on maps showing the interim biogeographic regions of Thackway & Cresswell (1995).

Placement of *Dicrastylis nicholasii* F. Muell.

One of the species included by Munir (1978) in *Dicrastylis* sect. *Corymbosae*, *D. nicholasii*, shows no close relationship to the other taxa he placed in this section, and does not match the original description of the section in its inflorescence. *Dicrastylis nicholasii* also differs from all other taxa that have been placed in sect. *Corymbosae* in being blue-flowered rather than white-flowered and in its distribution in a more arid part of Western Australia. It appears to be closely related to *D. flexuosa* (W.R. Price) C.A. Gardner, which it resembles in many characters including its inflorescence type and flower colour, and should certainly be placed in the same section as that species. Currently *D. flexuosa* is placed in *Dicrastylis* sect. *Verticillatae* Munir. However the delimitation of that section and two other sections of species occurring in the arid zone needs further study.

Descriptions and key

Dicrastylis sect. **Corymbosae** Munir (Munir 1978: 489). *Type: Dicrastylis corymbosa* (Endl.) Munir.

Mallophora Endl. *nom. rej.*, *Ann. Wien. Mus. Naturgesch.* 2: 206 (1838). *Type: Mallophora globiflora* Endl., lectotype, *fide* Munir (1978: 567) [= *Dicrastylis globiflora* (Endl.) Rye].

Lachnocephalus Turcz. *nom. rej.*, *Bull. Soc. Imp. Nat. Moscou* 22(2): 36 (1849). *Type: Lachnocephalus lepidotus* Turcz. [= *Dicrastylis globiflora* (Endl.) Rye].

Dwarf to medium-sized *shrubs*, all or most species producing multiple stems from a thick rootstock; stems with a dense indumentum of dendritic hairs. *Leaves* all or mostly opposite and decussate, dendritic-hairy at least on the veins of the lower surface. *Cymes* condensed into dense head-like or spike-like clusters, which are arranged in a terminal corymb or sometimes solitary and terminal on each branch. *Calyx* densely dendritic-hairy outside, glabrous inside; lobes 4 or 5(6), much longer than the tube. *Corolla* white, with long simple hairs inside on the base of the lobes and extending more than halfway down the tube, the base of the tube and most of the length of the lobes glabrous; lobes usually 4 or 5, rarely 6, more or less equal or the abaxial lobe somewhat larger than the rest, all shorter than the corolla tube, entire (not crenate). *Style* very shortly to deeply 2-branched.

Size and distribution. A section of five species from the south-west of Western Australia, occurring primarily in inland parts of the South West Botanical Province and extending slightly into adjacent parts of the South-western Interzone and Eremaean Botanical Province. Most of the species overlap in range. (Figure 1)

Notes. Sect. *Corymbosae* is similar to the other south-western group, sect. *Dicrastylis*, in having white flowers in a corymbose arrangement and with the margin of the petals entire. Unpublished molecular data (N. Streiber *pers. comm.*) indicate that these two groups are very closely related. Sect. *Corymbosae* can be distinguished from sect. *Dicrastylis* by its more condensed inflorescences and short corolla lobes in relation to the length of the corolla tube. In sect. *Dicrastylis* the corolla lobes are as long as or longer than the tube.

The three arid-zone sections of *Dicrastylis* need further study to reassess their boundaries, but can usually be readily distinguished from both of the south-western sections by their spike-like or pyramidal inflorescences as well as by their distribution patterns. They all occur in other states of Australia, and all of their Western Australian species are restricted to the arid zone except for one species that is associated with salt lakes in the south-west.

Key to species of *Dicrastylis* sect. *Corymbosae*

1. Flowers all 4-merous or with 5-merous flowers infrequent. Style divided for less than one third of its length, glabrous on upper half of the entire portion and on the branches
  2. Leaves ovate to narrowly obovate, 1.5–4 mm wide, usually densely hairy on upper surface at least at first, margins recurved. Flowers 6–7 mm long. Style branches 0.5–1 mm long at maturity. (Cadoux and Calingiri to Muntadgin.) ..... **D. globiflora**
  2. Leaves narrowly ovate or linear, 1–1.5 mm wide, largely glabrous on upper surface, margins revolute. Flowers 4–5 mm long. Style branches usually 0.2–0.3 mm long at maturity. (Mongers Lake to Bruce Rock to Die Hardy Range.) ..... **D. rugosifolia**
1. Flowers mostly 5-merous (rarely mostly 4-merous in *D. corymbosa*). Style divided for more than one third of its length, hairy throughout on the entire portion, with the hairs often extending onto the lower part of the branches
  3. Shrub *c.* 1 m high, occurring on granite outcrops. Leaves ovate or broadly ovate; undersurface with hairs restricted to the veins. (Pithara to Pingelly and Narembeen) ..... **D. reticulata**
  3. Shrub 0.1–0.6 m high, occurring on sandplains and other sandy habitats. Leaves ovate to oblong or (usually) narrowly so; undersurface hairy throughout

4. Leaves 4–12(15) mm long; upper surface usually grey-green, the revolute margins often green; undersurface with a dense, fairly uniform white indumentum. Bracts usually with pale to deep orange or purplish hairs. (Kirkalocka Station to east of Gnowangerup.) ..... **D. corymbosa**

4. Leaves 12–20 mm long; upper surface green; undersurface with a dense layer of minute white hairs and with much larger hairs (these may be lost from older leaves) scattered along the midvein and usually along other main veins. Bracts with white hairs. (Watheroo National Park to Yorkrakine.) ..... **D. velutina**

Dicrastylis corymbosa (Endl.) Munir, *Brunonia* 1: 500 (1978). – *Mallophora corymbosa* Endl., *Ann. Wien. Mus. Naturgesch.* 2: 207 (1838). *Type:* interior of south-western New Holland [Western Australia], *J.R. Roë* (*holo:* W, *n.v.*).

Dicrastylis stoechas Drumm. ex Harv., *Hooker's J. Bot. Kew Gard. Misc.* 7: 57 (1855). *Type:* south-west of Western Australia, *J. Drummond* coll. 5, suppl. 95 (*iso:* G *n.v.*, illustration seen).

Dicrastylis thomasiae S. Moore, *J. Linn. Soc., Bot.* 45: 209 (1920). *Type:* Western Australia, *Miss Thomas* (*holo:* BM, *n.v.*).

Shrubs usually 0.1–0.3 m high but one record of 0.6 m high. *Flowers* 4–6-merous, predominantly 5-merous or rarely predominantly 4-merous. For other characters see Munir (1978: 500–508).

Distribution and habitat. Occurs in the Avon Wheatbelt, Coolgardie, Jarrah Forest and Mallee biogeographic regions. Extends from an isolated record at Kirkalocka Station (north of Paynes Find) southwards to near Gnowangerup and inland to Barker Lake Reserve. Occurs in sandy habitats, recorded from tall shrublands, thickets and open woodlands, often dominated by mallee species. (Figure 1A)

Phenology. Flowers: September to April, especially October to February.

Notes. Dicrastylis corymbosa apparently tends to have a later flowering period than all other members of its section. It is very closely related to *D. velutina*, as discussed under that species.

Specimens of *D. corymbosa* from the northern part of the species range tend to have broader, more obviously hairy leaves than those from the southern part of the range, and more commonly have larger flowers that are very rarely 4-merous. A variant with extremely narrow leaves (including the type of *D. glauca*) is restricted to the Gnowangerup to Newdegate area and tends to have smaller flowers, sometimes with a high proportion of the flowers 4-merous. The narrow-leaved variant appears to intergrade completely with broader-leaved specimens, the intermediate specimens including *J.S. Beard* 3940 and *F.W. Humphries* 14 Nov. 1965. Munir (1978: 506) listed the former specimen as *Dicrastylis glauca*, but it has somewhat broader leaves than the other PERTH specimens listed and has some 6-merous flowers (rather than 4-merous ones) in addition to the usual 5-merous ones.

a. broad-leaved variant

Illustrations. Munir (1978: Figures B3, 18).

Selected specimens examined. WESTERN AUSTRALIA: 20 km SE of Biljahnie Rock on vermin fence, 3 Dec. 1997, *R.J. Cranfield* 11763 (PERTH); 1 mile [1.6 km] E of Lake Grace, 12 Oct. 1963, *K.R. Newbey* 1025 (PERTH); Pingaring Rock, 25 Nov. 1986, *K. White* 136 (PERTH); 5 miles [8 km] SW of Kulin, 18 Oct. 1974, *E. Wittwer* 1456 (PERTH).

Distribution. Occurring throughout the distribution of the species except in the far south where it is recorded only as far south as Pingrup.

Conservation status. Not considered to be at risk at present.

Notes. This variant includes the type of the species. Its flowers are predominantly 5-merous, but there are some specimens with a few 6-merous flowers and others with a few 4-merous flowers.

b. narrow-leaved variant

Dicrastylis glauca Munir, *Brunonia* 1 : 505–508 (1978). *Type:* Newdegate, December 1926, Western Australia, *C.A. Gardner* (*holo:* PERTH 01603132).

Illustrations. Munir (1978: Figures 16A, 19).

Selected specimens examined. WESTERN AUSTRALIA: Lakelands Nature Reserve, 17 Nov. 1998, *E. Bennett & A. Paton* LG 1.16 (PERTH); between Lake Grace and Hyden, 1 Oct. 1933, *W.E. Blackall* 3204 (PERTH 01082124, 03719081); E of Gnowangerup, 4 Jan. 1990, *Curtin University* SPA 283 (PERTH).

Distribution. Endemic to the Mallee biogeographic region, extending at least 130 km from Gnowangerup north-east to Newdegate and north of Lake Grace.

Conservation status. Conservation Codes for Western Australian Flora: Priority Three. This taxon may be at risk because it has a restricted distribution in the wheatbelt and is known from only one nature reserve.

Notes. Most of the few PERTH collections with very narrow leaves are listed above, including *W.E. Blackall* 3204. Munir (1978: 506, 575) cited one sheet (PERTH 01082124) of this collection as *Dicrastylis glauca* and a second sheet (PERTH 03719081) as *Mallophora rugosifolia*, although both specimens are clearly of the same taxon. This material is in bud, with the few flowers opened on the former sheet being 5-merous and the two open flowers of the latter sheet 4-merous. Without destroying the little material present on the latter specimen it was not possible to determine what proportion of the flowers are 4-merous but one of the more mature buds was dissected and found also to be 4-merous. This suggests that the majority of the flowers on the second sheet are 4-merous and that this specimen would not key accurately in Munir's key to genera (page 436), although its deeply divided style would allow it to be correctly keyed to *D. corymbosa* in the key provided here.

Dicrastylis globiflora (Endl.) Rye, *comb. nov.*

Mallophora globiflora Endl., *Ann. Wien. Mus. Naturgesch.* 2: 206 (1838). *Type:* interior of south-western New Holland [Western Australia], *J.R. Roë* (*holo:* W, *n.v.*, illustration seen).

Lachnocephalus lepidotus Turcz., *Bull. Soc. Imp. Nat. Moscou* 22(2): 36 (1849). *Type:* Swan River Colony [Western Australia], 1848, *J. Drummond* coll. 4: 235 (*syn:* KW *n.v.*); *Gilbert* 6 (*syn:* KW *n.v.*, photograph PERTH).

Illustrations. Diels & Pritzel (1905: Figure 55D,E), Munir (1978: Figures B3, 32).

Shrub usually 0.15–0.4 m high, possibly rarely to 0.5 m high. *Flowers* all 4-merous or mostly 4-merous with a few 5-merous. For other characters see description in Munir (1978: 569–574).

Selected specimens examined. WESTERN AUSTRALIA: along railway line NW of Wongan Hills township, 15 Sep. 1990, *D.E. Albrecht* 4477 & *B.A. Fuhrer* (PERTH); 3 km N of Cadoux, 20 Dec. 1984, *H. Demarz* 10535 (PERTH); *c.* 26 km N of Cunderdin on road to Wyalkatchem, 20 Oct. 1997, *B.J. Lepschi* 3608, *T.R. Lally & W.H. Treasure* (PERTH).

Distribution and habitat. Occurs in the Avon Wheatbelt and Yalgoo biogeographic regions. Extends from Cadoux south to Tammin National Park and from Calingiri and Northam east to Muntadgin. There are very few records of the vegetation, but the species appears to occupy the same habitat type as its close relative *D. rugosifolia*, apparently occurring in shrublands with a variety of associated species mainly of Myrtaceae, Proteaceae, *Acacia* or Casuarinaceae. (Figure 1B)

Phenology. Flowers: September to December.

Conservation status. Not considered to be at risk at present.

Notes. Based on old records with inaccurate localities, this species was erroneously included, as *Mallophora globiflora*, in the "Flora of the Perth Region" (Marchant *et al.* 1987). No members of the genus *Dicrastylis* are known from the region covered by that flora.

Dicrastylis rugosifolia is very closely related to *D. globiflora* but has smaller flowers in more elongate clusters, and has shorter, sometimes more revolute style branches. It also usually has narrower leaves distinguished by their less hairy and darker green upper surface with only 4 longitudinal rows of prominent bullae, whereas the more silvery upper surface of *D. globiflora* leaves has usually 6 or 8 rows of bullae that are often hidden by hairs.

Dicrastylis globiflora and *D. rugosifolia* overlap considerably in their distributions and a collection from east of Cadoux Siding (*C.A. Gardner* 2736) has mixed material of the two species. Some specimens from the Wongan Hills area have the inflorescence and floral characters that typify *D. globiflora* but have leaves with the upper surface more or less glabrous and dark green as in *D. rugosifolia*. These atypical specimens still appear to match *D. globiflora* because they mostly have 6 or 8 rows of bullae on the mature leaves.

Dicrastylis reticulata J.R. Drumm. ex Harv., *Hooker's J. Bot. Kew Gard. Misc.* 7: 57 (1855). *Type:* Western Australia, *J. Drummond* coll. 4: 94 (*lecto:* TCD, *fide* Munir (1978: 493), *n.v.*; *isolecto:* K *n.v.*, illustration seen).

Illustrations. Munir (1978: Figures A5, 15).

Shrub c. 1 m high. For other characters see Munir (1978: 492–496).

Selected specimens examined. WESTERN AUSTRALIA: 20 km W of Damboring, 26 Aug. 1971, *T.E.H. Aplin* 4857 (PERTH); Yorkrakine Rock Nature Reserve, Aug. 2001, *P. Roberts* (PERTH).

Distribution and habitat. Occurs in the Avon Wheatbelt and Mallee biogeographic regions. Restricted to granite outcrops, occurring in low shrublands amongst granite rocks or at the base of the granite, extending from near Pithara south to east of Pingelly and south-east to South Kumminin (near Narembeen). At one locality, the species was recorded growing with *Kunzea sericea*, whereas at another granite outcrop it was recorded with *Dryandra sessilis*, *Nuytsia floribunda* and *Allocasuarina humilis*. (Figure 1C)

Phenology. Flowers: late August to early December.

Conservation status. Conservation Codes for Western Australian Flora: Priority Three. A recent collection of this species, cited above, is perhaps the only one known from a nature reserve. There have been no other collections of this species since 1971, although its occurrence on granite outcrops suggests that it may be adequately protected.

Notes. This species is not particularly closely related to any other member of sect. *Corymbosae* and is the easiest one to identify. It is typically *c.* 1 m high, a larger shrub than all other members of the section, which are 0.1 to 0.6 m high. Perhaps the unique habitat of the species in the relatively mesic environment of granite outcrops could partially account for its greater size. *Dicrastylis reticulata* also has broader, greener (less hairy) leaves than the other species, and has more obvious, less densely hairy bracts.

The other four members of sect. *Corymbosae* are represented by whole plants on some of the herbarium sheets examined, and these invariably have multiple stems arising from the base. This habit is illustrated in Munir (1978: Figure 19A). Being a taller shrub, *D. reticulata* is always represented by cut branches on the herbarium sheets, and there is no information on the labels to indicate whether this species is single-stemmed or multi-stemmed at the base.

Dicrastylis rugosifolia (Munir) Rye, *comb. nov.*

Mallophora rugosifolia Munir, *Brunonia* 1: 574 (1978). *Type:* Wongan Hills, Western Australia, 6 November 1966, *A.M. Ashby* 2034 (*holo:* AD *n.v.*, illustration seen).

Illustrations. Munir (1978: Figures D6, 33).

Shrub 0.1–0.35 m high. For other characters see description in Munir (1978: 574–578).

Selected specimens examined. WESTERN AUSTRALIA: Bunjil Rd, 25.6 km E of Carnamah, 13 Oct. 1995, *A.R. Bean* 9050 (PERTH); Wubin, sign post N of town, 29 Sep. 1997, *B.A. Fuhrer* 97/67 (PERTH); Reserve 21601, Goodlands Rd, N of Kalannie, 31 Oct. 1995, *D.E. True* 10231 (PERTH).

Distribution and habitat. Occurs in the Avon Wheatbelt, Geraldton and Coolgardie biogeographic regions. Extends from near Mongers Lake and Marchagee south-east to Bruce Rock and east to Die Hardy Range. Occurs in shrublands with a variety of associated species, the predominant ones Myrtaceae, Proteaceae, *Acacia*, Casuarinaceae or *Actinostrobus* species. (Figure 1D)

Phenology. Flowers: August to December.

Conservation status. Not considered to be at risk.

Notes. Very closely related to *Dicrastylis globiflora* and differing as discussed under that species. See also the discussion under the narrow-leaved variant of *D. corymbosa*.

Dicrastylis velutina Munir, *Brunonia* 1: 496–500 (1978). *Type:* Bindi Bindi, *c.* 155 km north-north-east of Perth, Western Australia, 18 November 1964, *A.M. Ashby* 1363 (*holo:* AD, *n.v.*, illustration seen).

Illustrations. Munir (1978: Figures 16B–D, 17).

Shrub 0.3–0.6 m high. For other characters see Munir (1978: 496–500).

Selected specimens examined. WESTERN AUSTRALIA: E of farm block in centre of Watheroo National Park, 6 Dec. 1992, *E.A. Griffin* 8297 (PERTH); between Elphin and Piawaning, 21 Nov. 1961, *R.D. Royce* 6737 (PERTH).

Distribution and habitat. Occurs in the Avon Wheatbelt and Geraldton biogeographic regions. Extends from Watheroo National Park south-east to Yorkrakine (north of Tammin). Recorded on sandplains with low shrublands, the predominant species at the Watheroo National Park population being *Eremaea microphylla*, *Melaleuca seriata* and *Hakea brachyptera*. (Figure 1A)

Dicrastylis velutina was recorded from the Lake Grace area by Munir (1978) on the basis of two collections (*F.W. Humphreys* 14 Nov. 1965, *K.R. Newbey* 1025), both of which have now been redetermined as *D. corymbosa*.

Phenology. Flowers: recorded November and December.

Conservation status. Conservation Codes for Western Australian Flora: Priority Three. There has been only one recent collection of this species, but this fortunately is from a large national park.

Notes. Very closely related to *Dicrastylis corymbosa*, and more study is needed to determine how distinct these two taxa are. Their known ranges are allopatric, with *D. velutina* occurring north-west of the range of *D. corymbosa*. They may also differ in habitat, as *D. velutina* is recorded from low shrublands whereas *D. corymbosa* is recorded from taller shrublands and mallee woodlands. *D. velutina* tends to be a larger plant with coarser stem indumentum, broader leaves and longer basal peduncles on the inflorescences, but there is some overlap in these characters. According to Munir (1978), the two species differ in their

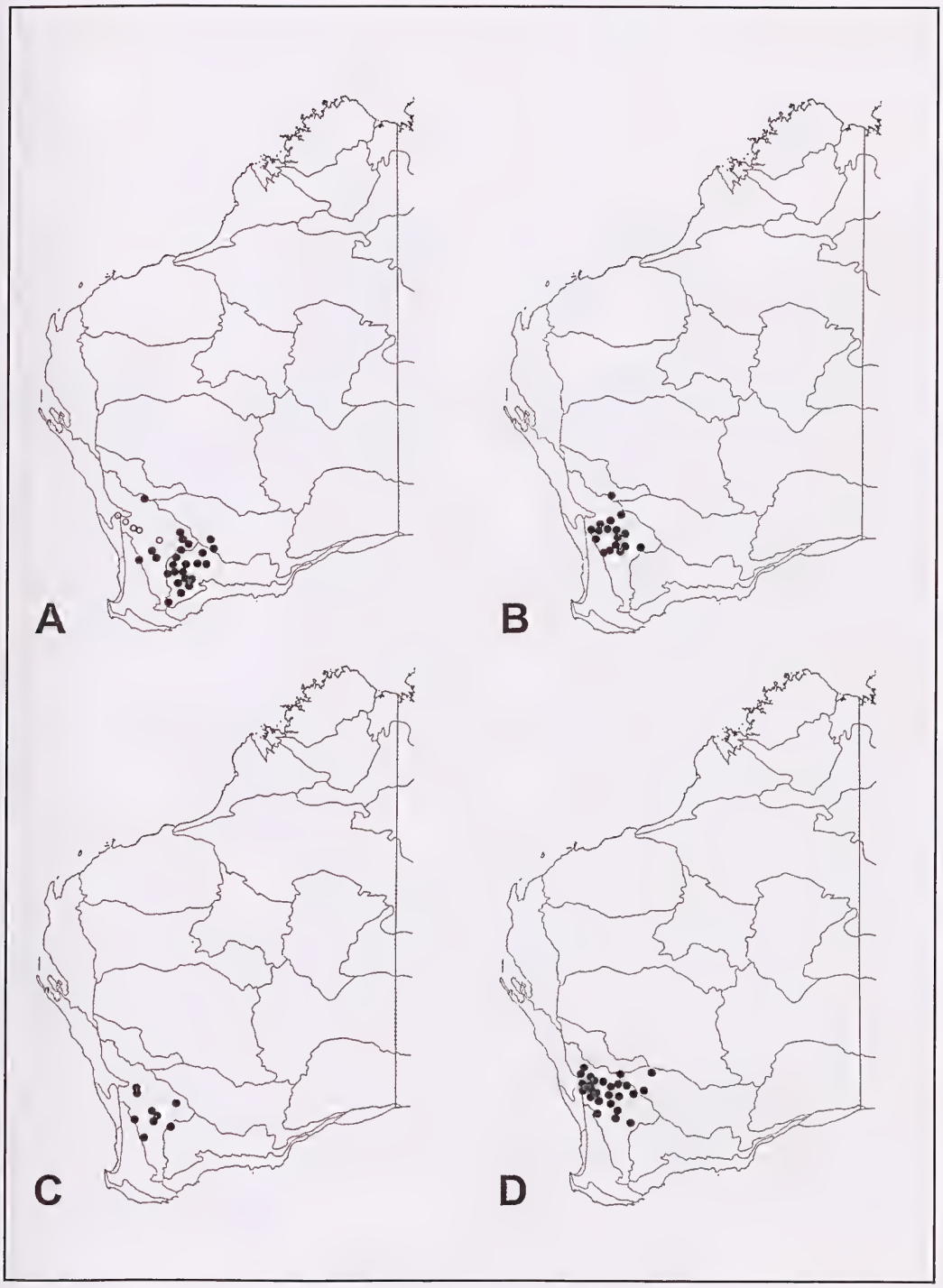

Figure 1. Distribution maps. A – *Dicrastylis corymbosa* ● and *D. velutina* ○ . B – *D. globiflora*; C – *D. reticulata*; D – *D. rugosifolia*.

ovary development such that *D. velutina* has four ovules in the mature ovary (Figure 17E,F) whereas *D. corymbosa* has two ovules aborting, resulting in only two ovules in the mature ovary (Figure 18F–H).

Discussion

Munir (1978: 444) separated *Mallophora* from *Dicrastylis* on the basis of its more condensed inflorescence, 4-merous flowers, and shorter style branches. The first of these three criteria is actually a valid reason to include *Mallophora* in *Dicrastylis* sect. *Corymbosae*, which is distinguished from other sections of *Dicrastylis* partly by having a similar inflorescence to that of *Mallophora*.

Munir gave undue weighting to the 4-merous character, using it also to delineate another small genus, *Physopsis* Turcz., and suggesting that *Mallophora* was more closely related to *Physopsis* than to the predominantly 5-merous *Dicrastylis*. Both the morphological evidence (Rye 1996) and molecular evidence (Olmstead *et al.* 1999, Streiber 2004) indicates, however, that *Mallophora* and *Physopsis* are not particularly close but are more closely allied to *Dicrastylis* and *Newcastelia* F. Muell. respectively.

In most *Dicrastylis* species, the numbers of floral parts vary not only between populations and individuals but also between flowers on the same individual. It is quite common for plants to produce a combination of 4- and 5-merous flowers or a combination of 5- and 6-merous flowers, and some specimens have been observed to vary from 4- to 6-merous. Much rarer in the genus are 7-merous flowers, and these have not been observed in sect. *Corymbosae*. Two species of *Dicrastylis* recently described by Munir (1991) appear to be predominantly 4-merous although they are not particularly closely related to the *Mallophora* species nor to one another. Even within sect. *Corymbosae* as delimited by Munir, the narrow-leaved variant of *D. corymbosa* may occasionally be predominantly 4-merous. It seems that taxa with predominantly 4-merous flowers have arisen independently in three sections of *Dicrastylis* as well as in several closely related genera. In view of the great variability in the numbers of floral parts, with some variation even occurring within *Mallophora sens. str.*, there is no justification in using this character to separate the two genera.

Similarly, the degree of branching of the style does not give a complete separation between *Mallophora* and *Dicrastylis*. *Mallophora rugosifolia* does have particularly short style branches, however *M. globiflora* has somewhat longer branches that show some overlap with relatively short-branched species of *Dicrastylis sens. str.* such as *D. cordifolia* Munir.

One alternative to disbanding *Mallophora* would be to expand its circumscription to include all members of *Dicrastylis* sect. *Corymbosae*, but this section does not appear to merit separation at the generic level any more than any other sections of *Dicrastylis*. In conclusion it appears that there are no good grounds for maintaining *Mallophora* as a separate genus and that *Dicrastylis s. lat.* (i.e. including *Mallophora*) is a natural, well defined genus.

Acknowledgements

I would like to thank Nikola Streiber for showing me her unpublished molecular data and Paul Wilson for advice on nomenclature.

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A taxonomic update of *Petrophile* sect. *Arthrostigma* (Proteaceae)

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Abstract

Rye, B.L. and Hislop, M. A taxonomic update of *Petrophile* sect. *Arthrostigma* (Proteaceae). *Nuytsia* 15(3): 457–483 (2005). *Petrophile* sect. *Arthrostigma* (Endl.) Benth. is described, *P. teretifolia* R. Br. is chosen as its lectotype, and a key is given for all members of the section. *Petrophile filifolia* R. Br. and *P. juncifolia* Lindl. are reinstated. Descriptions are also given for five new taxa, *Petrophile filifolia* subsp. *laxa* Rye & Hislop, *P. pilostyla*, *P. pilostyla* subsp. *austrina*, *P. pilostyla* subsp. *syntoma* and *P. prostrata*, and for two species that are now more narrowly circumscribed, *P. brevifolia* R. Br. and *P. longifolia* R. Br. A lectotype is also selected for *P. longifolia*. Pollen presenter characters, which are of particular importance in this group, are compared in a table and are illustrated for all of the named taxa.

Introduction

In a recent paper (Hislop & Rye 2002) dealing with three new species of *Petrophile* R. Br., it was noted that the PERTH collections of both *Petrophile brevifolia* and *P. longifolia* were heterogeneous and needed further study. One of the variants of *P. brevifolia* had already been placed under the manuscript name *P. latericola* Keighery and a variant of *P. longifolia s. lat.* was allocated the informal name *Petrophile* sp. prostrate (*J.W. Horn & R. Butcher* 2649). The aim of the present study was to examine type material of members of this species group to establish the correct application of the published names, and to describe any taxa in the group that proved to be new or significantly altered in their circumscription. A further aim was to provide a key to all of the named taxa, and details and illustrations of the pollen presenters as a further means of identifying them.

As noted by George (1998), recent works have not established an updated infrageneric classification for *Petrophile*. The species examined here belong to *Petrophile* sect. *Arthrostigma*, one of four sections that were delimited informally by Brown (1810b) and one of six sections recognised by Bentham (1870). Although this old classification needs some modification to incorporate all of the species currently recognised, section *Arthrostigma* appears to be a natural group and hence a suitable one to examine as a whole in the current study. Other named sections in the genus mostly appear to be less well defined. They include a number of new species which will be treated in a later paper.

For those members of *Petrophile* sect. *Arthrostigma* that are not described here, descriptions are available in Foreman's (1995) treatment of the genus in Volume 16 of "Flora of Australia" or in Hislop & Rye (2002). Continually updated distribution maps are available for all taxa on FloraBase (Western Australian Herbarium, 1998 onwards).

Materials and methods

Measurements and conservation status. Similar methods were used in this study to those described in our earlier paper (Hislop & Rye 2002).

Interpretation of the type localities. Brown (1810a,b) named a number of species of *Petrophile* based on his collections made from King George Sound and other coastal localities. In a later work, Brown (1830) based additional new taxa in the genus on Baxter's specimens from 1828–1829, in every case giving the locality as "ora occid.-merid., King George's Sound". However, on the label of each specimen examined here, the locality is recorded vaguely as the south-west coast of New Holland. Unlike Robert Brown, William Baxter collected his specimens not only on the coast but also at least as far inland as the Stirling Range. Evidence for this is that his specimens include *Petrophile anceps* R. Br., a Stirling Range endemic.

It appears that *Petrophile* taxa represented at King George Sound were all or mostly named by Brown based on his own collections whereas the ones he named later were mostly those occurring further inland or on the coast further east and hence not available to him until he was able to use Baxter's specimens. The type localities for Baxter specimens given in the current study as "Stirling Range to the south coast" would therefore mostly not have been collected exactly at King George Sound but somewhat inland or further east of the sound.

Descriptions and key

Petrophile section **Arthrostigma** (Endl.) Benth., Fl. Austral. 5: 321 (1870). – *Petrophile* sect. I. R. Br., Prod. 364 (1810). – *Petrophile* a. *Arthrostigma* Endl., Gen. Pl. 337 (1837). *Type: Petrophile teretifolia* R. Br., lectotype here designated.

Leaves simple, narrow, terete or compressed, obtuse to pungent-pointed. *Inflorescences* more or less sessile, compact; involucral bracts and cone scales not viscid, completely glabrous or ciliate in most taxa. *Tepals* separating fully, becoming spirally twisted, white to yellow or pinkish outside, glabrous inside, not viscid; claw glabrous at base, the remainder densely hairy; limb often darker than the claw and often brownish or greyish, hairy throughout or with longitudinal subglabrous stripes, without a distinct terminal glabrous appendage. *Pollen presenter* often minutely papillose, with a distinct glabrous base below the brush; base turbinate to very narrowly obovate, usually truncate at summit, often prominently 4-ridged; brush rather sparsely hairy to very dense, with a more or less cylindric axis distinctly narrower than the truncate summit of the base (except in *P. antecedens*) but the whole of it (including the hairs) as broad or broader than the base, the hairs acute to distinctly clavate. *Nut* small (2–3.5 mm long), compressed but not winged, with a coma of very long marginal hairs, the two surfaces shallowly and often unequally convex, with short hairs at least along the midline of each surface and often also some much larger hairs.

Size and distribution. Endemic to the south-west of Western Australia, with 17 named species, two of which have subspecies, giving a total of 20 taxa. One additional species is known by a manuscript name.

Common names. Probably the best known species in the section is Pixie Mops, *Petrophile linearis*, which is common on the Swan Coastal Plain including the remnant bushland of many Perth suburbs. This species is illustrated in Rye (1987: Figure 128). Very few other members of the genus have common names.

History and lectotypification. Brown (1810b) included three species, *P. teretifolia*, *P. filifolia* and *P. acicularis*, in his *Petrophile* sect. I, and all three species match his description of the section in all details. The first species listed, *Petrophile teretifolia*, is selected here as the lectotype of the section. Endlicher (1837) named the group *Arthrostigma*, but without specifying the rank, and did not include any additional species. Bentham (1870) specified the sectional level for the group and added five species that had been named by Brown (1830), these being *P. anceps* R. Br. [as *P. linearis* var. *anceps* (R. Br.) Benth.], *P. juncifolia* R. Br. [as *P. media* var. *juncifolia* (R. Br.) Benth.], *P. linearis* R. Br., *P. media* R. Br. and *P. longifolia*.

Recently, descriptions and illustrations of five additional members of the section, *P. antecedens* Hislop & Rye, *P. aspera* C.A. Gardner ex Foreman, *P. clavata* Hislop & Rye, *P. helicophylla* Foreman and *P. nivea* Hislop & Rye, have been published (Foreman 1990, Hislop & Rye 2002). However, these and other recent works have not used, nor even discussed, any infrageneric classification for the genus. It would appear from the systematic arrangement of the species of all members of the genus by Foreman (1995) that he considered the two species with uniformly compressed leaves not to be closely allied to the other members of the group, although he placed all other members of sect. *Arthostigma* together. Apart from this single character difference in the leaves, there appears to be no basis for separating these two taxa into a separate species group, and it should be noted that *P. megalostegia* F. Muell. also very rarely has compressed leaves.

Pollination. Four species of native bees have been recorded visiting the flowers of *Petrophile linearis* (Houston 2000). The significance of the very varied pollen presenters in *Petrophile* species may be related to pollinator specificity but this remains to be studied.

Distinguishing characteristics. Sect. *Arthrostigma* is distinguished from other sections of *Petrophile* by a combination of the characters given above, especially by its pollen presenter shape and brush. The brush generally has larger hairs than in the other sections, with the hairs sometimes so dense that the brush axis is completely obscured. Sect. *Xerostole* (*P. biloba* R. Br., *P. heterophylla* Lindl., *P. squamata* R. Br. and *P. striata* R. Br.) has the pollen presenter of a similar shape (although tending to be more fusiform in *P. biloba*) but with the upper part either glabrous or sparsely hairy with very short hairs. In the other sections the pollen presenter is more or less fusiform. Members of these sections have small, often very sparse hairs, which commonly extend more or less for the entire length of the pollen presenter. Generally, although the term 'brush' is applied to the hairy portion in these other sections, it is mainly in sect. *Arthrostigma* that the hairy portion is really brush-like in appearance.

It is also the only section in which all species have simple entire leaves, and most species have glabrous involucral bracts and cone scales. In the other sections divided and/or toothed leaves are common and the only species outside sect. *Arthrostigma* that has glabrous bracts is *Petrophile carduacea* Meisn. In other species the bracts are invariably hairy, at least on the margins or inside, and are sometimes viscid.

Tepal characters may also be significant. In sect. *Arthrostigma*, the tepals separate to the apex when the flower opens, the claw of each tepal is densely hairy outside except at the base and the apical appendage of the limb is always hairy. In other species groups the tepal claws are sometimes glabrous or not very densely hairy, many species have a long glabrous apical appendage on each limb, and in some species the tepals are shed together.

Variation within the section. Growth habits vary within the section from strictly prostrate, as in *P. helicophylla* Foreman, to erect and up to 2 m tall in *P. teretifolia* R. Br. Some taxa appear to be very variable in habit, particularly *P. brevifolia s. lat.* which varies from low and widely spreading to 2 m tall. *P. brevifolia* is also the most variable species in other respects and it needs further study to determine whether infraspecific taxa or additional species need to be recognised. Some taxa (e.g. *P. linearis* R. Br.) have a lignotuber while others (e.g. *P. teretifolia*) do not and are killed by fires (George 1984).

Petrophile anceps and *P. linearis* can generally be distinguished readily from other members of the section by their flattened rather than terete leaves. One odd specimen of *P. megalostegia* (*E.A. Griffin* 2183) differs from all the rest in having flattened leaves like those of *P. linearis*. However, in all other characters it is typical of *P. megalostegia* and so does not appear to be a hybrid between these two taxa but just an exceptional member of the former species.

The two very closely related species *Petrophile antecedens* Hislop & Rye and *P. clavata* Hislop & Rye can be readily distinguished from other members of sect. *Arthrostigma* by their hairy stems and involucral bracts. *P. antecedens* is also atypical of the section in being the only species with a more or less fusiform pollen presenter. However there can be little doubt that it is closely related to *P. clavata* and the two species fit best within this group in other regards.

The cone scales are usually completely glabrous on both surfaces, but rarely may be somewhat hairy along the centre outside in a few taxa and are fairly commonly so in *Petrophile pilostyla* subspp. *austrina* and *syntoma*. The upper cone scales may also be ciliate in sect. *Arthrostigma*, as in *Petrophile teretifolia*, but are more often glabrous. Flower colour varies from white to a bright yellow and to pink-purple. The most common colour in the group is cream to pale yellow.

Of particular importance in distinguishing the taxa in this section are the many characters relating to the pollen presenter, which in some taxa is so distinctive as to be unique in the genus. Figures 1 and 2 illustrate the pollen presenters of all currently recognised members of this section. Table 1 compares a good number of these pollen presenter characters among the members of sect. *Arthrostigma*. Additional characters of significance include the density of the brush and the colour and shape of the base.

Notes. Authorship of this section, given as *Petrophile* sect. *Arthrostigma* (Endl.) Kuntze, was incorrectly attributed by Chapman (1991: 2222) to Kuntze (1904: 427), who was simply following the much earlier treatment by Bentham (1870). Bentham similarly treated two other names that Endlicher had erected for groups of unspecified rank in *Petrophile*, these becoming sect. *Symphyolepis* (Endl.) Benth. and sect. *Xerostyle* (Endl.) Benth., although he neglected to cite Endlicher's name for the latter. While it could possibly be argued that he had named a new section *Xerostyle*, it is clear from his use of Endlicher's name and his referral to Endlicher in other parts of his treatment, that this was just an accidental omission and should not be regarded as the naming of a new section.

Key to the species and subspecies of *Petrophile* sect. *Arthrostigma*

1. Leaves flattened
  2. Involucral bracts ovate or almost elliptic, the upper ones acute. Tepals yellow and *c.* 30 mm long. (Mullewa to Badgingarra.) ..... **P. megalostegia** (atypical)
  2. Involucral bracts linear-subulate, acuminate. Tepals either pink-mauve or *c.* 15 mm long

3. Tepals *c.* 15 mm long, yellow. Pollen presenter brush with obtuse or slightly clubbed hairs 0.15–0.2 mm long. (Stirling Range.) ..... **P. anceps**
3. Tepals 25–35 mm long, pink-mauve. Pollen presenter brush with acute hairs 0.3–0.5 mm long. (Dongara to Scott River.) ..... **P. linearis**

1. Leaves terete
4. Branchlets densely hairy; involucral bracts densely hairy at base. Pollen presenter brush sparsely hairy with distinctly clubbed hairs, the axis clearly visible
5. Pollen presenter 1.5–2.2 mm long, the swollen portion more or less fusiform and partially hairy, the glabrous base about as long as the brush. Involucral bracts conspicuously brown above the grey-hairy base. (York to Harrismith.) ..... **P. antecedens**
5. Pollen presenter 3–4 mm long, the swollen portion very narrowly turbinate, glabrous and much longer than the more cylindrical brush. Glabrous part of involucral bracts more slender and less conspicuous than in *P. antecedens*. (Alexander Morrison National Park to Calingiri.) ..... **P. clavata**
4. Branchlets and involucral bracts glabrous. Pollen presenter brush either very dense, the axis obscured by the very numerous hairs, or with hairs acute or obtuse
6. Pollen presenter brush very dense, the axis obscured by very numerous hairs which are usually all clubbed (rarely some obtuse in *P. longifolia*)
7. Strictly prostrate plants with erect spirally twisted leaves. Pollen presenter 6.3–7.5 mm long. (Pingrup to Newdegate to Ravensthorpe.) ..... **P. helicophylla**
7. Prostrate to erect plants with straight to slightly twisted leaves. Pollen presenter 3–5.5 mm long
8. Leaves coarsely scabrous. Occurring inland (Narrogin to Lake Grace) ..... **P. aspera**
8. Leaves smooth or very finely scabrous. Occurring on or near the south coast
9. Upper cone scales (in flower) ciliate. Tepals pink-mauve turning whitish. Brush of pollen presenter 3–4 mm long, more than twice as long as base (Stirling Range to Israelite Bay.) ..... **P. teretifolia**
9. Cone scales entire or denticulate. Tepals cream or yellow. Brush of pollen presenter 2–3 mm long, usually 1–2 times as long as base
10. Growth habit very low and spreading to erect, the leaves surrounding the stems and flower heads. Flower heads held above ground level, 18–35(40) mm diam. (Stirling Range to Albany to Cheyne Bay.) ..... **P. longifolia**
10. Growth habit strictly prostrate, with the leaves congregated to one side of the stems and flower heads. Flower heads held at ground level, (30)35–55 mm diam. (Jerramungup to Cheyne Bay to Fitzgerald River.) ..... **P. prostrata**
6. Pollen presenter brush sparse to dense, with the upper hairs acute; basal hairs acute except in *P. filifolia* where they are occasionally obtuse
11. Hairs on pollen presenter with a recurved apex. Cone scales very prominently striate; upper cone scales ciliate. (Scott River to Two Peoples Bay.) ..... **P. acicularis**
11. Hairs on pollen presenter patent or incurved. Cone scales not very prominently striate; upper cone scales ciliolate or glabrous

12. Involucral bracts brown throughout
13. Leaves very crowded, concealing the branchlets and involucral bracts, commonly 10–15 mm long, pungent. Tepals white. Pollen presenter brush sparse, with more or less patent hairs. (Near Eneabba.) ..... **P. nivea**
13. Leaves not so crowded as to obscure the branchlets and bracts from view, 110–300 mm long, not pungent. Tepals cream or yellow. Pollen presenter brush dense, with all or some hairs antrorse
14. Hairs on pollen presenter uniformly antrorse, straight. (Coastal plain from Perth to Busselton and northern Darling Range) ..... **P. juncifolia**
14. Pollen presenter with the basal hairs usually much more strongly antrorse than those above so as to give the appearance of a constriction between the base and the brush, the remaining hairs patent to widely antrorse and incurved
15. Tepal limb with a tight, uniformly antrorse indumentum 0.3–0.5(0.7) mm long. Pollen presenter with brush hairs 0.3–0.4 mm long. (Dryandra State Forest to Perup River to Albany and Stirling Range) ..... **P. filifolia** subsp. **filifolia**
15. Tepal limb with a loose indumentum of mostly patent and some widely antrorse hairs 0.7–1 mm long. Pollen presenter with brush hairs 0.5–0.8 mm long. (Armadale to Wandering) .... **P. filifolia** subsp. **laxa**
12. Involucral bracts grey throughout or partially grey
16. Involucral bracts ovate or almost elliptic, the upper ones shortly acute. Tepals *c.* 30 mm long. (Mullewa to Badgingarra.) ..... **P. megalostegia**
16. Involucral bracts very narrowly ovate, the upper ones long-attenuate. Tepals 10–25 mm long or rarely up to 33 mm long in *P. brevifolia*
17. Leaves 80–300 mm long, sometimes with a pungent point 0.5–1.5 mm long but more commonly not pungent
18. Leaves 80–150(220) mm long. Pollen presenter brush 1.5–2.3 mm long, moderately dense, with axis clearly visible; hairs 0.3–0.45 mm long. (Williams to Manjimup to Ravensthorpe.) ..... **P. media**
18. Leaves 150–300 mm long. Pollen presenter brush 2–3 mm long, dense, with axis partially hidden; hairs 0.5–0.7 mm long. (Coastal plain from Perth to Busselton and northern Darling Range) ..... **P. juncifolia**
17. Leaves 10–110 mm long, with a pungent point 1–3 mm long
19. Outer involucral bracts grey above a brownish base or grey throughout. Style sparsely to densely hairy at least in basal half or very rarely glabrous; expanded portion of pollen presenter without raised papillae although cell pattern may be evident
20. Tepals 9.5–12.5 mm long. Pollen presenter 4.5–5.5 mm long, about as long as or not much shorter than the remainder of style, which is very densely hairy. (Indarra area) ..... **P. pilostyla** subsp. **syntoma**
20. Tepals (10.5)12–18 mm long. Pollen presenter 3.5–5 mm long, much shorter than the remainder of style, which is glabrous to densely hairy
21. Cone scales glabrous to ciliate towards apex; longest cilia 0.1–0.25 mm long. Style densely hairy in lower half. (Tamala Station to Moresby Range to Yuna area) ..... **P. pilostyla** subsp. **pilostyla**

21. Cone scales ciliate or densely ciliate towards apex; longest cilia 0.25–0.4 mm long. Style glabrous to densely hairy in lower half. (Eneabba to Watheroo National Park.) ..... **P. pilostyla** subsp. **austrina**

19. Outer involucral bracts distinctly bicoloured, with a brown central stripe and grey margins. Style glabrous or very rarely with 1 or 2 hairs; expanded portion of pollen presenter minutely but distinctly papillose. (Irwin River to Perth to near Ravensthorpe.) ..... **P. brevifolia** complex (including *P. latericola* ms.)

Petrophile acicularis R. Br., *Trans. Linn. Soc. London* 10: 69 (1810). – *Protea acicularis* (R. Br.) Poir. *in* J.B.A.P. de M. de Lamarck, Encycl. Suppl. 4, 559 (1816). *Type citation:* "Lewin's Land, New Holland". *Type:* King George Sound, [Western Australia], December 1801, *R. Brown* (*lecto:* BM 0006232036, *fide* Foreman (1995: 474); *isolecto:* BM 000632033).

For a description of this species see Foreman (1995: 163). (Figure 1A)

Selected specimens examined. WESTERN AUSTRALIA: Boulder Hill, Pt 5455, Two Peoples Bay, 6 Oct. 1992, *A.R. Annels* 2620 (PERTH); Fishermen Rd, 8.4 km of road SE of beach at Broke Inlet, 21 Nov. 1990, *N. Gibson & M. Lyons* 873 (PERTH); King George Sound, *B.T. Goadby* B.2377, Oct. 1898 (PERTH); Torndirrup National Park, S of Albany, 28 Nov. 1986, *G.J. Keighery* 8815 (PERTH); Galamup Nature Reserve, 34°26'S, 116°46'E, 22 Oct. 1997, *G.J. Keighery & N. Gibson* 2251 (PERTH); King George Sound, Nov. 1909, *J.H. Maiden* (NSW); Stirling Terrace, King George Sound, 21 Sep. 1840, *J.A.L. Preiss* 626 (PERTH); Brockman Highway, E of Nillup, 30 Oct. 1948, *R.D. Royce* 3008 (PERTH); Nut Rd, *c.* 0.5 km N of junction with Ficifolia Rd, Walpole–Nornalup National Park, 16 Oct. 1991, *J.R. Wheeler* 2788 (PERTH).

Distribution and habitat. Extends along the south coast from the Scott River area east to Two Peoples Bay and inland to near Manjimup.

Phenology. Flowers recorded September to late November.

Notes. When Foreman (1995: 474) nominated the lectotype for this species, he gave "Lewin's Land" as the locality for this specimen (as given in Brown's (1810a) protologue) but gave "King George Sound" as the locality for a second specimen that had the Britten no. 3242, although the labels of both specimens indicate the same locality of King George Sound. Both were collected by Robert Brown in December 1801. Leeuwin's Land, given with a variety of spellings, was then used for the whole of the south-west corner of New Holland, including King George Sound. Brown's south-western Australian collections were from three localities, King George Sound, Lucky Bay and Goose Island Harbour (Vallance *et al.* 2001) but *Petrophile acicularis* occurs at only the first of these localities. It seems likely that the two sheets at BM were part of the same collection, and therefore the one with the Britten number 3242 is assumed here to be an isolectotype rather than a lectoparatype.

Petrophile acicularis differs from its closest relatives in having recurved hairs on the pollen presenter brush. The species is also generally recognisable by its very prominently striate cone scales.

Petrophile brevifolia Lindl., Sketch Veg. Swan R. 35 (1840). – *Petrophile media* var. *brevifolia* (Lindl.) Domin, *Vestn. Král. Ceské Spolecn. Nauk. Tr. Mat.-Prír.* 1921–1922(2): 2 (1923). *Type:* Swan River Colony [Western Australia, probably collected 1835–1838 by *J. Drummond*] (*holo:* CGE *n.v.*, photograph PERTH 01593382).

Shrubs regenerating after fire from a lignotuber and often multi-stemmed, sometimes with a combination of prostrate and erect stems, often widely spreading, commonly 0.2–0.5 m high, sometimes more erect and up to 1.5(2) m high. *Branchlets* prominently ribbed, grey, glabrous. *Leaves* usually mostly spreading or with at least some widely spreading below each flower head, well spaced to somewhat crowded, terete, straight to strongly curved or somewhat s-shaped, 25–100 mm long, 1–2.5 mm diam., glabrous; point pungent, 1–3 mm long. *Flower heads* usually few and mostly terminating branchlets, sometimes more numerous with lower ones fairly common, sessile, globose, 35–50 mm diam. *Involucral bracts* few to numerous, erect, subulate or very narrowly ovate, 8–15 mm long, acuminate, distinctly bicoloured at first with a brown thickened midrib contrasting with grey margins, becoming more uniformly grey with age, glabrous. *Cone scales* usually more or less ovate, 4.5–8.5 mm long, acute or acuminate, brown, nearly always glabrous outside, denticulate or entire, usually glabrous or with a few minute cilia near centre of each margin. *Tepals* 15–33 mm long; claw cream to medium yellow or pink-mauve, glabrous at base, with a very dense indumentum above of widely antrorse to patent hairs; limb 3.5–7 mm long, often somewhat more coloured than the claw, densely antrorse-hairy outside but sometimes with longitudinal glabrous or subglabrous longitudinal strips, the hairs 0.4–0.7 mm long. *Anthers* 2–3.3 mm long. *Style* glabrous or very rarely with one or several hairs. *Pollen presenter* 3.5–6 mm long; base 1.3–3.5 x 1–1.3 mm, 4-lobed, deep yellow turning orange or reddish, minutely but distinctly papillose; brush moderately dense (the axis visible), 1.3–3 mm long, 0.7–1.3 mm diam., when short then often not reaching summit of the thickened base, with a stout to moderately slender axis, which often tapers strongly from the base upwards, and numerous or fairly numerous patent or widely antrorse acute hairs 0.25–0.5 mm long; glabrous apical tip 0.4–1.3 mm long. *Cones* depressed globose to very broadly ovoid, 10–19 x 11–17 mm; scales broad, multi-ribbed but the ribs not always obvious. *Nuts* depressed ovate to very broadly obovate in outline, 2–3 x 2.5–4 mm, apex shallowly or very shallowly acute, the attached base of the style often forming a long point; abaxial surface with appressed or closely antrose white or rarely pale orange hairs *c.* 0.5 mm long very densely arranged along the middle and usually more scattered elsewhere, rarely also with long orange hairs at summit; adaxial surface with large orange to deep ferruginous hairs 3.5–4.5 mm long forming a prominent coma and very scattered to densely arranged on the surface. (Figure 1E,F)

Selected specimens examined. WESTERN AUSTRALIA: between Gingin and Regan's Ford, 22 Sep. 1962, *J.S. Beard* 1812 (PERTH); near Hinsa Hill, 13 miles [21 km] W of Merredin, *W.E. Blackall* (PERTH); Nature Reserve 16479, 25 km W of Jitarning, 12 Oct. 1984, *J.M. Brown* 014 (PERTH); Humphrey Rd, off Wyatt Rd, Gnowangerup, 15 Oct. 1990, *E.J. Croxford* 6444 (PERTH); 3 km N of Regans Ford, 14 Sep. 1995, *R. Davies* 102 (PERTH); Kings Park, 29 Nov. 1972, *P. Fairall* 2188 (PERTH); Capitella Rd, SE of Dandaragan, 30 Sep, 1998, *E.A. Griffin* 5356 (PERTH); Yardanogo Nature Reserve, 6.5 km S of Mt Adams, 13 Oct. 1989, *E.A. Griffin* 5557 (PERTH); Hi Vallee (property of D. & J. Williams), Warradarge, on W side of breakaway above creek, 23 Oct. 1999, *M. Hislop* 1781 (PERTH); Yarra Rd, 1 km S of Crawler Rd then *c.* 250 m W towards a granite outcrop, 9 Nov. 1998, *F. Hort* 307 (PERTH); Ningana Block, N of Pipidinny Rd, 3.5 km W of Wanneroo Rd, 12 Dec. 1990, *B.J. Keighery* 817B (PERTH); 11 km E of Cervantes, 21 Oct. 1990, *G.J. Keighery* 11872 (PERTH); Fowler's Gully, S end of Wongan Hills, *c.* 2 km S of Wongan Hills–Piawaning road, 29 Sep. 1985, *K.F. Kenneally* 9532 (PERTH); Eneabba, adjacent to golfcourse, 29 Oct. 1992, *A.M. Lyne* 953, *L. Craven & F. Zich* (PERTH); NE corner of junction of Jurien Bay Rd and Cockleshell Gully Rd, 11 Sep. 1999, *M. Puckridge* 88 (PERTH); race track E of rail reserve at SW boundary,

Corrigin, 18 Sep. 1995, *A. Saunders* CGN64 (PERTH); 0.5 mile [0.8 km] along Sappers Rd towards Karakin Rd, E of Lancelin, 29 Sep. 1966, *E.M. Scrymgeour* 1342B (PERTH).

Distribution and habitat. Irwin River south to Perth and south-east to near Ravensthorpe. On the coast between Mt Adams and Lancelin, *P. brevifolia* occurs in yellow, white or grey sand over limestone, in fairly exposed sites with low open shrubland, often with *Dryandra sessilis*. From Guilderton south to Perth it occurs in deep sand or in sand over limestone, in shrublands, *Banksia* woodlands or Tuart forest. Inland from these areas in the northern part of its range, the species is often a component of mixed heathland or very open mallee woodland, especially on lateritic uplands. In the south-eastern part of its range, between Tammin and Ravensthorpe, *P. brevifolia* is recorded in clayey or sandy soils, often with gravel or over laterite.

Phenology. Flowers from September to December.

Delimitation of taxa. The description given here for *Petrophile brevifolia* is a greatly reduced circumscription of the species in comparison with that accepted by Foreman (1995) and previous workers on the genus. However, even after the removal of the newly recognised species *Petrophile pilostyla* from amongst the material previously housed under *P. brevifolia s. lat.*, the specimens remain extremely variable and are referred to jointly in the key as the *P. brevifolia* complex. This complex includes *Petrophile latericola* Keighery ms., a taxon G.J. Keighery established for specimens occurring in a few populations at the base of the Whicher Range. These populations represent a significant disjunction for the *P. brevifolia* complex as a whole and differ from typical *P. brevifolia* in their short and usually rather erect leaves and ciliate cone scales, and in their non-lignotuberous habit.

However, specimens that match *P. latericola s. str.*, at least in having short erect leaves and ciliate scales, extend northwards along the Darling Range to the Mogumber area and then north to Arrowsmith River, although north of York the scales are often only very sparsely ciliate or glabrous. It remains to be seen whether the Darling Range and more northern specimens resemble the Whicher Range specimens in being uniformly non-lignotuberous and should be combined with it, but at least some of the northern populations are known to be non-lignotuberous. These short-leaved specimens (from Whicher Range and northwards), are referred to here as *P. latericola s. lat.* They possibly show some tendency to flower earlier and occupy more moist habitats than the other elements of the *P. brevifolia* complex.

Petrophile brevifolia and *P. latericola s. lat.* overlap in range in the region from York northwards but may be partially separated by the habitat and flowering time differences that were noted above. Both are very variable, each with several local variants, showing a pattern of variation that is especially complex in the northern sandplains, where the morphological differences listed above may not be sufficient to fully separate the two taxa. At the same time there is some specimen-based evidence to suggest that they may coexist in a specific area while maintaining these core differences. One mixed collection (*C.A. Gardner* 9296) made in August 1949 from near Dandaragan has a flowering specimen of *P. latericola s. lat.* and a non-flowering specimen that seems to match *P. brevifolia*, but there is no indication on the label as to how closely they were associated at this site.

Collections of *Petrophile brevifolia* (*F. & J. Hort* 1860) and *P. latericola s. lat.* (*F. & J. Hort* 1859) made in early October south of Badgingarra are especially noteworthy. They were collected *c.* 1.5 km apart in apparently similar habitats of heath on gravelly sandy soil. The morphological differences as

outlined above were quite clear between the two taxa there. *P. latericola s. lat.* had a tall erect growth habit and very pale yellow heads that were close to the end of flowering, whereas *P. brevifolia* had a low spreading habit and larger brighter yellow heads in early flower.

Further research is needed to determine how many taxa should be recognised formally within the *Petrophile brevifolia* complex. This probably needs to involve extensive fieldwork to establish which variants have a lignotuber, their respective flowering periods, whether and where the variants grow together and a close investigation of those sites where problematic collections have been made.

Type locality. The type material of *Petrophile brevifolia* was collected prior to 1840 in the Swan River Colony, which may by then have been explored as far as the Moore River in the north, York in the east and the Murray River to the south, but is most likely to have come from close to the Swan River Estuary. Its leaves, with a maximum length of *c.* 35 mm, could fit any of the members of the complex as they are near the short extreme of the 30–100 mm range of leaf length found in *P. brevifolia* and are longer than most specimens of *P. latericola s. lat.*, in which the leaves are generally 10–40 mm long. It can be concluded from Lindley's notes (1840) that the flowers were bright yellow like most of those found in Perth suburbs and surrounding areas, and from its spreading leaves that it is *P. brevifolia* rather than *P. latericola*, and it is probably the variant that is found on the Swan Coastal Plain. The type photograph and a more recent photocopy examined are clear enough to show the typical two-toned colouration of the bracts but not to discern details of the pollen presenter, which tends in the Swan Coastal Plain variant to have a more bushy brush with longer hairs than in other variants.

Notes. In addition to the typical variant of *Petrophile brevifolia* from the Swan Coastal Plain, the variants in this extremely variable species include a pink-flowered one on coastal limestone between Mt Adams and Lancelin and a small-flowered one in the south-east, extending from Tammin to Ravensthorpe. The south-eastern variant tends to have short leaves, sometimes down to *c.* 30 mm long, short tepals down to 15 mm long and a short pollen presenter down to 3.5 mm long. The greatest variability, however, occurs in the northern sandplain areas, where the flowers are sometimes very large (expecially on *E.A. Griffin* 3266) and the pollen presenter is up to 6 mm long.

Throughout the species range, most specimens are low but some are 1 m or more, the maximum height recorded being 2 m for one of the specimens from the Wongan Hills (*K.F. Kenneally* 9532). Leaf thickness varies considerably, often on a single specimen, and one with particularly thick leaves is *W. Greuter* 22393. The cone scales are nearly always glabrous outside but *R.D. Royce* 9754 has them hairy outside at the centre and glabrous around the margin. The style is completely glabrous in most specimens but a few northern specimens (e.g. *A.M. Lyne* 953, *L. Craven & F. Zich*) have one or several widely scattered hairs on the style.

Petrophile brevifolia may occasionally hybridise with the flat-leaved and pink-flowered *P. linearis* but the evidence is confused by the occurrence also of a pink-flowered variant in *P. brevifolia*. The pink- and yellow-flowered variants of *P. brevifolia* are not completely separated geographically and may coexist at a location near Dandaragan. A pink-flowered narrow-leaved specimen (*E.A. Griffin* 5357) collected there could possibly be a hybrid between a typical yellow-flowered *P. brevifolia* (represented by *E.A. Griffin* 5356) and *P. linearis* (represented by *E.A. Griffin* 5355), but is assumed here to be an isolated inland occurrence of the pink-flowered variant of *P. brevifolia*. A more likely intermediate between the two species is *B. Evans* WE 716 from Cockleshell Gully, also with pink flowers but with its leaves more flattened.

Petrophile filifolia R. Br., *Trans. Linn. Soc. London* 10: 69 (1810). *Type:* ora occid.-merid., King George Sound, [Western Australia], December 1801, *R. Brown* [*Britten* 3243] (*holo:* BM 000632034, 000632035).

Shrubs ascending to *c.* 0.5 m but usually lower, single-stemmed at ground level and probably always with a fire sensitive rootstock. *Branchlets* ribbed, glabrous, usually greyish brown at maturity, but younger branchlets pale brown or red purple. *Leaves* erect, terete, gently to strongly curved, (110)130–280 mm long, 0.9–1.5 mm diam., glabrous, usually smooth but very occasionally finely scabrous; apex a pale to dark brown, blunt or coarsely pungent, more or less uncinate mucro to 2 mm. *Flower heads* terminal on branchlets, sessile, mostly globose, less often depressed globose or broadly ovate, (20)25–45 mm diam. *Involucral bracts* usually few and rather inconspicuous, narrowly ovate to very narrowly ovate, acuminate, brown throughout but paler towards margins and apex. *Cone scales* obovate to broadly obovate, 6–11 x 4–6(7) mm, acute to acuminate, glabrous except for marginal tufts of antrorse hairs close to base and occasionally a few basal hairs on abaxial surface, brown, faintly ribbed, not or rarely becoming recurved. *Tepals* 17–25 mm long, usually cream or pale yellow throughout, rarely pink-tinged; claw glabrous at base, densely hairy above with an indumentum of widely antrorse to patent hairs; limb 3–4.4 mm long, densely hairy outside with either all hairs antrorse and 0.3–0.5 mm long or a mixture of patent and widely antrorse hairs 0.7–1 mm long. *Anthers* 1.8–2.9 mm long. *Style* glabrous. *Pollen presenter* 3.6–5.5 mm long, yellow turning orange; base 1–2.5 x 0.8–1 mm, usually quadrangular in cross section with thickened rounded angles, less often more or less terete; brush very dense 2.5–3.2 mm long (including glabrous tip), 0.8–1.3 diam., the axis usually concealed by the patent or widely antrorse, mostly incurved (occasionally only apical hairs incurved) and acute hairs (very occasionally the basal hairs blunt), the lowest hairs on the brush just above the base much more steeply antrorse than those above so as to give the appearance of a constriction at this point. *Cones* ovoid or broadly ovoid, 15–28 x 14–20 mm. *Nuts* usually broadly elliptic to elliptic in outline, less often broadly obovate or obovate, 1.8–3.2 x 1.5–2.8 mm including the acute style base; the abaxial surface usually glabrous but occasionally with a few antrorse hairs on the persistent style base, brown and often with 2 darker, elliptic markings on either side of the medial line; the adaxial surface densely covered by very short dark purple hairs overtopped by a moderately dense layer of golden-brown (possibly rarely white) antrorse hairs, which become denser towards the margin to form a conspicuous coma 2.5–4.5 mm long.

Distribution and habitat. Extends from Armadale south to Perup River and south-east to the Stirling Range and Albany. Occurs in a variety of habitats, often on winter-wet flats but also occurring in well drained habitats.

Phenology. Flowers mainly October to January.

Affinities. Petrophile filifolia was incorrectly placed in synonymy under *P. acicularis* by Bentham, who did still recognise the taxon under his new name of *P. longifolia* var. *tenuifolia*. Bentham (1870: 322) distinguished it from typical *P. longifolia* by its "Leaves longer and more slender, the cones and flowers smaller, the cone scales broader and less acuminate". Foreman (1995) followed Bentham in misplacing *P. filifolia* as a synonym of *P. acicularis*, but did not consider *P. longifolia* var. *tenuifolia* to be distinct, listing it as a synonym of *P. longifolia*. Certainly, Bentham's characters do not give a sound basis for the separation of these two taxa.

Confusion over the identity of this species may have resulted from some mislabelling of specimens, as a Robert Brown specimen (NSW 131386) from King George Sound labelled *Protea filifolia* does not match the BM type material of *P. filifolia*, but instead is *P. acicularis*. This specimen is definitely not an isotype of *P. filifolia* but could possibly be an isotype of *P. acicularis*.

Petrophile filifolia is reinstated here. It has a fairly wide range in the south-west, and overlaps with *P. longifolia* in the far south-east of its range. It tends to flower later in the year than *P. longifolia* and differs in having longer hairs on the pollen presenter. The basal hairs of its brush are generally closely antrorse whereas the remaining hairs are more spreading; this makes the pollen presenter appear to be somewhat constricted immediately above the expanded base. In contrast in *P. longifolia* there is no apparent constriction in the brush because all of the hairs are patent or widely antrorse. Brush hairs in *P. filifolia* are all acute or very occasionally the lowest hairs are obtuse, whereas those of *P. longifolia* are all clubbed or very occasionally the upper hairs are obtuse rather than clubbed. Apart from these pollen presenter differences, *P. filifolia* also has generally narrower cone scales and smaller nuts than *P. longifolia*.

Although the leaves of *Petrophile filifolia* are usually smooth, some specimens have finely scabrous leaves (e.g. *E.D. Kabay* 835) and these could possibly be confused with the coarsely scabrous leaves found in *P. aspera*. However, *P. aspera* also differs in pollen presenter details, having a characteristically short base (0.5–1 mm long) and proportionally long brush (3.4–4.8 mm long) with clavate hairs.

Notes. There are two main geographically distinct variants of *P. filifolia*, which are treated here as subspecies. They differ in minor indumentum characters of the tepals and pollen presenter brush.

a. Petrophile filifolia R. Br. subsp. **filifolia**

Petrophile longifolia var. *tenuifolia* Benth., Fl. Austral. 5: 322 (1870). *Type:* stony places, Kalgan River, [Western Australia], *A.F. Oldfield* 420 (*holo:* K, photograph PERTH 01543857).

Illustration. Blackall & Grieve (1988: 153) [as *Petrophile longifolia*].

Tepals cream or pale yellow; limb densely hairy with a tight, uniformly antrorse indumentum 0.3–0.5(0.7) mm long. *Pollen presenter* with brush hairs 0.3–0.4 mm long. (Figure 1H)

Selected specimens examined. WESTERN AUSTRALIA: Picnic area off Crapella Rd, Albany Highway, 20 km N of Kojonup, 5 Feb. 1997, *R. Davis* 2516 (PERTH); 0.5 km SW of Stirling Range National Park on Red Gum Pass Rd, 24 Sep. 1984, *D.B. Foreman* 839 (NSW, PERTH); between Unicup Lake and Kulunilup Lake, 34°21'S, 116°46'E, 2 Nov. 1977, *A.S. George* 15034 (PERTH); King George Sound, *B.T. Goadby* B.2375 (PERTH); Salt River Rd, Stirling Range National Park, 14 Oct. 1994, *E.D. Kabay* 835 (PERTH); 19 km NW of Wagin to Arthur River, 26 Nov. 1984, *G.J. Keighery* 7406 (CANB *n.v.*, PERTH); Millbrook Nature Reserve, 35 km NNE of Albany, 2 Nov. 1986, *G.J. Keighery* 8948 (PERTH); 50 km SE of Mayanup, 5 Nov. 1990, *G.J. Keighery* 12136 (PERTH); *c.* 62 km along Chester Pass Rd from Borden towards Albany, 3 Nov. 1992, *A.M. Lyne* 986, *L. Craven & F. Zich* (CANB *n.v.*, MEL *n.v.*, NSW, PERTH); Red Gum Spring, Stirling Range, Oct. 1963, *R. Rogerson* 55 (PERTH); Dryandra State Forest, 3 Nov. 1987, *D.M. Rose* 463 (PERTH); Drawbin Rd, *c.* 2 km off South Coast Highway, 25 Sep. 1982, *A. Strid* 20533 (PERTH).

Distribution and habitat. Extends from Arthur River and Dryandra State Forest south-east to the Stirling Range and Albany and as far east as the Hassell National Park. Also occurs in the Lake Muir to Tonebridge area. Occurs in dry or winter-wet sites usually on sandy soils, but also recorded in heavier soils, in heath or woodland.

Phenology. Flowers mainly October to January.

Notes. Two variants that are currently housed under this subspecies need further study to assess their taxonomic status. One consists of the somewhat disjunct south-western populations which, unlike their eastern counterparts, appear to be restricted to winter-wet habitats. These plants are apparently also taller with a more open growth habit. Another variant is known from two specimens collected in the Stirling Range (*B. Barnsley* 730, *R.J. Hnatiuk* 761436). This variant is typical of *P. filifolia* in all respects except that its pollen presenter lacks a definite constriction.

b. Petrophile filifolia subsp. **laxa** Rye & Hislop, *subsp. nov.*

A subspecies typica indumento tepalorum longiore laxiore, pilis in pollinis praebitor longioribus differt.

Typus: Brookton Highway, 1.55 km east of Omeo Rd, Clare State Forest, Armadale, Western Australia, 27 November 2000, *F. Hort* 1249 (*holo:* PERTH 05732956; *iso:* MEL).

Tepals usually cream or pale yellow, rarely pink-tinged; limb densely hairy with a loose indumentum of mostly patent and some widely antrorse hairs, 0.7–1 mm long. *Pollen presenter* with brush hairs 0.5–0.8 mm long. (Figure 1I)

Other specimens examined. WESTERN AUSTRALIA: Shulstaad Rd, 2.4 km E of the power lines then 250 m N on sand track, Leona State Forest, Wandering, 13 Nov. 2003, *F. & B. Hort* 2097 (PERTH); Brookton Highway, 8 km SE of Kinsella Rd, 1 Dec. 2004, *F. & B. Hort* 2437 (PERTH); Brookton Highway, along Canning River East *c.* 1 km WSW from Omeo Rd, 15 Dec. 2004, *F. & B. Hort* 2489 (PERTH); Barrett Rd, 2.3 km N of Wearne Rd, Wearne State Forest, Wandering, 14 Jan. 2001, *F. & J. Hort* 1270 (PERTH); Barrett Rd, 2.2 km N of Wearne Rd, Wearne State Forest, Wandering, 5 Mar. 2001, *F. & J. Hort* 1276 (PERTH).

Distribution and habitat. Known only from the Armadale to Wandering area of the Darling Range. Recorded from dry or winter-wet woodland or heath in sandy soils.

Phenology. Flowers between November and January.

Conservation status. Conservation Codes for Western Australian Flora: Priority Two. Known from about five relatively secure populations in State Forest.

Etymology. The subspecies epithet is from the Latin *laxus* – loose or open – referring to the characteristically open and spreading tepal indumentum.

Notes. The nearest known populations of *Petrophile filifolia* subsp. *filifolia* occur at Dryandra State Forest and in the Arthur River–Wagin area, *c.* 50 km to the south-east and 90 km to the south-south-east respectively, from the southernmost population of subsp. *laxa*. Plants from these areas are typical of subsp. *filifolia* throughout its range in respect to perianth indumentum and length of brush hairs. There are two collections from the Lake Unicup area east of Manjimup (*R.J. Cranfield* 16032 and *G.J. Keighery & N. Gibson* 2651) that approach subsp. *laxa* in having a longer, more spreading indumentum (to 0.7 mm) on the perianth limb. However the brush hairs are typical of subsp. *filifolia* and the limb indumentum is certainly denser than in subsp. *laxa*. All other collections at PERTH from these south-western populations have the perianth indumentum of the typical subspecies.

One recently collected specimen of this subspecies had pinkish flowers, but occurred in a population (*F. & B. Hort* 2437) where the usual cream or pale yellow colour predominated.

Petrophile juncifolia Lindl., Sketch Veg. Swan R. 35 (1840). – *Petrophile media* var. *juncifolia* (Lindl.) Benth., Fl. Austral. 5: 323 (1870). *Type:* Swan River, 1839, *J. Drummond* in Herb. J. Lindley (*holo:* CGE).

Illustrations. Blackall & Grieve (1988: 153) [as *P. media* var. *juncifolia*] and probably also the pollen presenter labelled "brush silky-hairy" [as *P. media* var. *media*].

Leaves 150–300 mm long, usually not pungent but often terminating in a slightly to very curved apical point 0.5–1(1.5) mm long. *Pollen presenter* 4–5 mm long; base 1–1.5 mm long; brush 2–3 mm long, 1.2–1.4 mm diam., dense, the axis partially hidden, with widely antrorse hairs 0.5–0.7 mm long. In other respects this taxon matches the description of *P. media* given in Foreman (1995: 164). (Figure 1K)

Selected specimens examined. WESTERN AUSTRALIA: Mundijong Rd, 200 m E of intersection with Kargotich Rd, 6 Nov. 1997, *R. Davis* 4453 (PERTH); Watershed Rd, 6.9 km S of Brookton Highway, 1 Nov. 1998, *F. Hort* 287 (PERTH); Twin Swamps Nature Reserve, Almeria Parade, 7 km N of Upper Swan, 10 May 1992, *B.J. Keighery & N. Gibson* 842 (PERTH); Fish Rd Nature Reserve, 13 km SW of Busselton, 3 Jan. 1991, *G.J. Keighery* 11588 (PERTH); 2 km N of Waroona, 23 Oct. 1992, *G.J. Keighery* 12231 (PERTH); Pinjarra, Murray River, 9 Oct. 1897, *R. Helms* (PERTH); Cannington, lower Canning River, 10 Aug. 1899, *A. Morrison* (PERTH); 30 km E of Perth at junction: The Lakes, Nov. 1920, *Wilson & Herbert* (PERTH).

Distribution and habitat. Occurs in winter-wet habitats on the coastal plain from Perth south to Waroona, with an isolated record from Busselton. There are also a couple of records from the Darling Range near Perth, where the species appears to grow in a drier habitat.

Notes. This species was reduced to a variety of *Petrophile media* by Bentham (1870) and then placed in synonymy under that species by Foreman (1995). It is reinstated here as it has significant differences in its pollen presenter measurements (see Table 1), also generally having longer leaves and a quite distinct distribution, with *P. juncifolia* in the north and west and *P. media* in the south and east. The differences between the two taxa are too great to treat them as varieties, but there is some doubt as to whether subspecific or specific rank is most appropriate for them.

The type specimen has a less hairy pollen presenter than usual in this taxon, with the hairs relatively short. One specimen that was reportedly collected within the range of *P. media* at Tambellup in January 1932 is typical of *P. juncifolia*, suggesting that the locality is incorrect.

Petrophile longifolia R. Br., Suppl. Prod. Fl. Nov. Holl. 5 (1830). – *Petrophile longifolia* var. *lorea* R. Br. *nom. illeg.* [= var. *longifolia*], Suppl. Prod. Fl. Nov. Holl. 5 (1830). *Type:* south-west coast of New Holland, [Stirling Range to the south coast, Western Australia], 1828–1829, *W. Baxter* (*lecto:* BM 000632028, here chosen; *isolecto:* NSW 131367).

Petrophile longifolia var. *caulescens* R. Br., Suppl. Prod. Fl. Nov. Holl. 5 (1830). *Type:* south-west coast of New Holland, [Stirling Range to the south coast, Western Australia], 1828–1829, *W. Baxter* (*holo:* BM 000623030).

Illustration. Figure 94H of Foreman (1995), which was drawn from *J.A.L. Preiss* 625 (MEL).

Shrub usually low and spreading or ascending but sometimes more erect, 0.25–0.5 m high, single-stemmed at the base and very erect at first, becoming divided into multiple spreading branches at or close to the base but probably always with a fire-sensitive rootstock. *Branchlets* sometimes yellowish brown and fairly smooth at first but soon becoming strongly irregularly ribbed and very dark red-brown, often glossy at this stage, eventually becoming grey, glabrous. *Leaves* mostly very dense and closely surrounding the flower heads, more distant on the non-flowering portion of the branches, terete, straight or more frequently gently to strongly curved, 150–350 mm long, 0.8–1.6 mm diam., glabrous; apex a dark, blunt or coarsely pungent, slightly uncinate mucro to 1.5 mm long. *Flower heads* terminal on branchlets, sessile, globose or depressed globose, 18–35 mm diam. *Involucral bracts* rather inconspicuous, ovate or narrowly ovate, acuminate, glabrous, yellowish brown to dark brown, thin and sometimes paler on margins. *Cone scales* broadly to depressed ovate, 7–10 x 5–9 mm, acute to acuminate, glabrous, medium to very dark brown, not or faintly ribbed, often becoming recurved. *Tepals* 11–18 mm long, cream or pale yellow throughout; claw glabrous at base, densely hairy above with an indumentum of widely antrorse to patent hairs; limb 4–5 mm long, densely hairy, the hairs antrorse and *c.* 0.5 mm long. *Anthers* 1.5–2.3 mm long. *Style* red and glabrous except for the pollen presenter brush. *Pollen presenter* 3–4.5 mm long; base 0.9–1.6 x 0.8–1.3 mm, angular and often distinctly flattened, usually with 4 more or less prominent longitudinal ribs, yellow turning orange; brush very dense, 1.9–3 mm long (including glabrous tip), 0.8–1.1 mm diam., the axis totally concealed by the patent or widely antrorse, incurved and clavate hairs (occasionally upper hairs blunt but unexpanded apically) 0.3–0.5 mm long, that so crowd the truncate apex of the base as to form the appearance of a solid outline between base and hairs. *Cones* mostly broadly or very broadly ovoid and 10–15 x 10–20 mm; scales with the distal portion clearly demarcated and often darker brown at maturity. *Nuts* with a very broadly obovate body topped by a triangular persistent style base, commonly 3–4.5 x 2–2.5 mm including the acute style base; the abaxial surface usually glabrous but occasionally with a few antrorse hairs on the persistent style base, brown and often with 2 darker, elliptic markings on either side of the medial line; the adaxial surface densely covered by very short dark purple hairs overtopped by a moderately dense or dense layer of golden-brown (possibly rarely white) antrorse hairs *c.* 2 mm long, and with a very dense longer indumentum of the latter hairs 2–4 mm long concentrated close to the margins to form a conspicuous coma. (Figure 2B)

Selected specimens examined. WESTERN AUSTRALIA: near Stirling Range, Oct. 1903, *C. Andrews* (PERTH); E of Cranbrook on N edge of Stirling Range,16 Oct. 1962, *T.E.H. Aplin* 2023 (PERTH); Warringup, Stirling Range, Sep. 1946, *A. Ashby* 1 (PERTH); Toolbrunup, Stirling Range National Park, 15 Sep. 1965, *A.C. Beauglehole* 12959 (PERTH); metal dump in reserve, Pfeiffer Rd, Manypeaks, 13 Aug. 1996, *E.J. Croxford* 7467 (PERTH); on the road to Bluff Knoll, 2 miles [3 km] in from highway, Stirling Range National Park, 27 Sep. 1966, *R. Filson* 8995 (PERTH ex MEL); King George Sound, Oct. 1898, *B.T. Goadby* B.2374 (PERTH); access track to Granite Hill Nature Reserve, 1.4 km E of Moorialup Rd at junction of a minor track, 16 Nov. 2003, *M. Hislop* 3086A,B (PERTH); S side of Millbrook Nature Reserve, *c.* 15 km N of Albany, 5 Nov, 1996, *A.R. Mast & D.S. Feller* 321 (PERTH); Reserve 13240, Cheyne Bay, N of Cape Riche, 24 Oct. 1996, *J.W. Mercer* 91 (PERTH); "Inter frutices densos planitiei subturfosae ad radices montis Wuljenup" Mt Wuljenup [Willyung Hill], Oct. 1840, *J.A.L. Preiss* 625 (MEL); 60 km NE of Albany on road to Jerramungup, 10 Nov. 1974, *D.J.E. Whibley* 5228 (PERTH); Hamilla Hill on Hancock Property 9 miles [14 km] along Salt River Rd from Cranbrook, Stirling Range National Park, 9 Oct. 1968, *J.W. Wrigley* (NSW).

Distribution and habitat. Extends from the northern edge of Stirling Range National Park south to Mt Willyung at Albany and east to Cheyne Bay. Recorded in sandplain and in sandy soils over laterite, in low woodlands dominated by *Banksia*, *Eucalyptus*, *Hakea* and *Acacia* spp.

Phenology. Flowers from mid August to early November. Fully mature nuts measured from *A.R. Mast*

& D.S. Feller 321 and *D.J.E. Whibley* 5228 for the southern variant and *C. Andrews* Oct. 1903 for the typical variant. Immature nuts can be identified readily by the large size of the style base in relation to the nut body and may have white rather than golden brown hairs, although it is possible some mature nuts also have white hairs.

Conservation status. Conservation Codes for Western Australian Flora: Priority Three. This taxon is possibly at risk as recent attempts to collect it were unsuccessful through most of its range. It has not been collected in the Stirling Range since 1968. Perhaps it is highly susceptible to fires, dieback or general disturbance. Certainly it needs to be monitored.

Type information. Brown (1830) listed two varieties under *P. longifolia*, the first given as *á. lorea* and the second as *ß. caulescens*, and did not indicate which of the two should be regarded as the typical variety. Two specimens of Baxter's at BM correspond with these two taxa. The one selected here as the lectotype of the species was originally identified as *Petrophile lorea* R. Brown ined., with a later identification as *P. longifolia* var. *lorea* added to the same label. A determinavit attached to this specimen by Foreman and dated 30 July 1990 states that it is the lectotype both of *Petrophile longifolia* and its var. *lorea*, but this intended lectotypification was not published in his flora treatment of the genus (Foreman 1995). The lectotype matches a number of PERTH specimens collected from the Stirling Range (e.g. *R. Filson* 8995) that have flower heads borne close to the ground and long erect leaves.

Affinities. See notes under *P. filifolia* which was previously considered [as *P. longifolia* var. *tenuifolia*] to be a variant of *P. longifolia*. If the two taxa had proved to be synonymous, it would have been necessary to adopt the older name *P. filifolia*. However, true *P. longifolia* and its variant *P. longifolia* var. *caulescens* apply to a distinct complex and are restricted to the Stirling Range to Albany and Manypeaks area. A third member of the complex, occurring further east, is named below as *P. prostrata*.

Notes. This taxon is variable in its growth habit. Some collectors record the habit as prostrate, but *Petrophile longifolia* is never truly prostrate, unlike its close relatives *P. helicophylla* and *P. prostrata*. Near Granite Hill Nature Reserve, between Porongurup and Manypeaks, a population was sampled (*M. Hislop* 3086A & B) comprising individuals that varied from very low and spreading (to *c.* 0.25 x 0.5 m) when growing in the open, to erect and up to 0.5 m high where in close competition with other plants.

Apart from this variability in growth habit there is a tendency for the northern collections from the vicinity of the Stirling Range to have larger floral parts and possibly a lower growth habit than those from farther south. These slight differences are the same as those observable between the type of *P. longifolia* and that of *P. longifolia* var. *caulescens* (with the former corresponding to the northern entity) and appear to form the basis of Brown's original separation. We have not observed *P. longifolia* in the Stirling Range area, where there have been no collections since the late sixties. However given the relatively slight and overlapping size difference in floral parts and the variability in growth habit noted above, the recognition of a second taxon here is not tenable at this stage. It should be noted that the larger-flowered Stirling Range specimens form the closest approach to the morphology of *P. prostrata* although still quite distinct in their habit and possibly also distinct in their nuts.

Petrophile media R. Br., Suppl. Prod. Fl. Nov. Holl. 5 (1830). – *Petrophile media* var. *typica* Domin *nom. illeg.* [= var. *media*], *Vestn. Král. Ceské Spolecn. Nauk. Tr. Mat.-Prír* 1921–22(2): 2 (1923). *Type:* south-west coast of New Holland, [Stirling Range to the south coast, Western Australia], 1828–1829, *W. Baxter* (*holo:* BM 000632031, 000632032).

Illustration. Blackall & Grieve (1988: 153), including the pollen presenter labelled "brush thinly hirsute" [as *Petrophile media* var. *media*].

Leaves up to 220 mm long but usually 80–150 mm long, usually not pungent but often terminating in a slightly to very curved apical point 0.5–1(1.5) mm long. *Pollen presenter* 3.5–5.5 mm long; base 1.2–2.3 mm long; brush 1.5–2.3 mm long, 0.6–1 mm diam., moderately dense, the axis clearly visible, with widely antrorse to patent hairs 0.3–0.45 mm long, the uppermost hairs sometimes much shorter than the rest. For other characteristics of this species see the description of this species in Foreman (1995: 164). (Figure 2C)

Selected specimens examined. WESTERN AUSTRALIA: Perup fire effects study plots, near corner of Northern and Boyup Brook–Cranbrook roads, *c.* 45 km E of Manjimup, 4 Nov. 1997, *A.R. Annels* 5986 (PERTH); 17.5 km SSE of Arthur River along Albany Highway, 23 Oct. 1983, *R.J. Cranfield* 4657 (PERTH); reserve, corner of Narrikup Rd and Albany Highway, 19 Nov. 1983, *E.J. Croxford* 5739 (PERTH); 2 km N of Narrikup, 31 Oct. 1995, *R. Davis* 259 (PERTH); 15 km along Koorong Rd from South West Highway, *c.* 42 km W of Ravensthorpe, 29 Nov. 1985, *D.B. Foreman* 1334 (PERTH); N of Mt Toolbrunup, Stirling Range, 13 Nov. 1069, *V. Mann & A.S. George* 139 (PERTH ex K); Mount Barker, Dec. 1898, *R. Helms* (PERTH); 65 km NE of Albany on Jerramungup road, 10 Nov. 1974, *D.J.E. Whibley* 5241 (PERTH).

Distribution and habitat. Extends from the Williams area south-east to Manypeaks and east-south-east to Ravensthorpe. Grows on a variety of soils in heath or open woodland in dry or winter-wet sites.

Affinities. Petrophile media has been confused with the species now known as *P. filifolia* and less frequently with *P. brevifolia*, although it shows greater similarities to the latter. *P. media* differs from *P. brevifolia* in its usually longer leaves and the more uniform colouration of its involucral bracts. Whereas the leaves of *P. brevifolia* are invariably pungent-pointed, those of *P. media* are more commonly blunt, the rather blunt point, when present, tending to be shorter and often on a strongly recurved apex. In *P. brevifolia* the inflorescence size is much more variable than in *P. media* but more uniformly globular in shape and the cone scales tend to be broader and shorter, and less obvious than the very numerous involucral bracts.

However, the closest relative of *Petrophile media* is *P. juncifolia*, which differs as described under that species. *P. media* was described as a very variable species by Blackall & Grieve (1988) and their illustration on page 153 includes three pollen presenters, showing the very hairy pollen presenter of *Petrophile juncifolia* [as var. *juncifolia*], and two pollen presenters labelled "brush thinly hirsute" and "brush silky-hairy" respectively for *P. media* [as var. *media*]. The thinly hirsute pollen presenter is typical of *P. media* but the silky hairy one appears to belong to *P. juncifolia*. There has clearly been some confusion between the two taxa as the range given by Blackall & Grieve for *P. media* incorrectly included Cannington, Pinjarra and Armadale, where only *P. juncifolia* occurs.

Notes. The type locality for *Petrophile media* was given as King George Sound by Brown (1830) but the specimen was probably collected a short distance away as there are no recent collections from that precise locality. The species is known from both north and east of King George Sound, for example at Narrikup and Manypeaks.

Two specimens (*R.J. Cranfield* 4657, *D.B. Foreman* 1334) of *Petrophile media* have unusually long leaves *c.* 220 mm long and one other specimen collected near the former specimen has leaves almost as long. All other specimens examined have leaves 80–150 mm long.

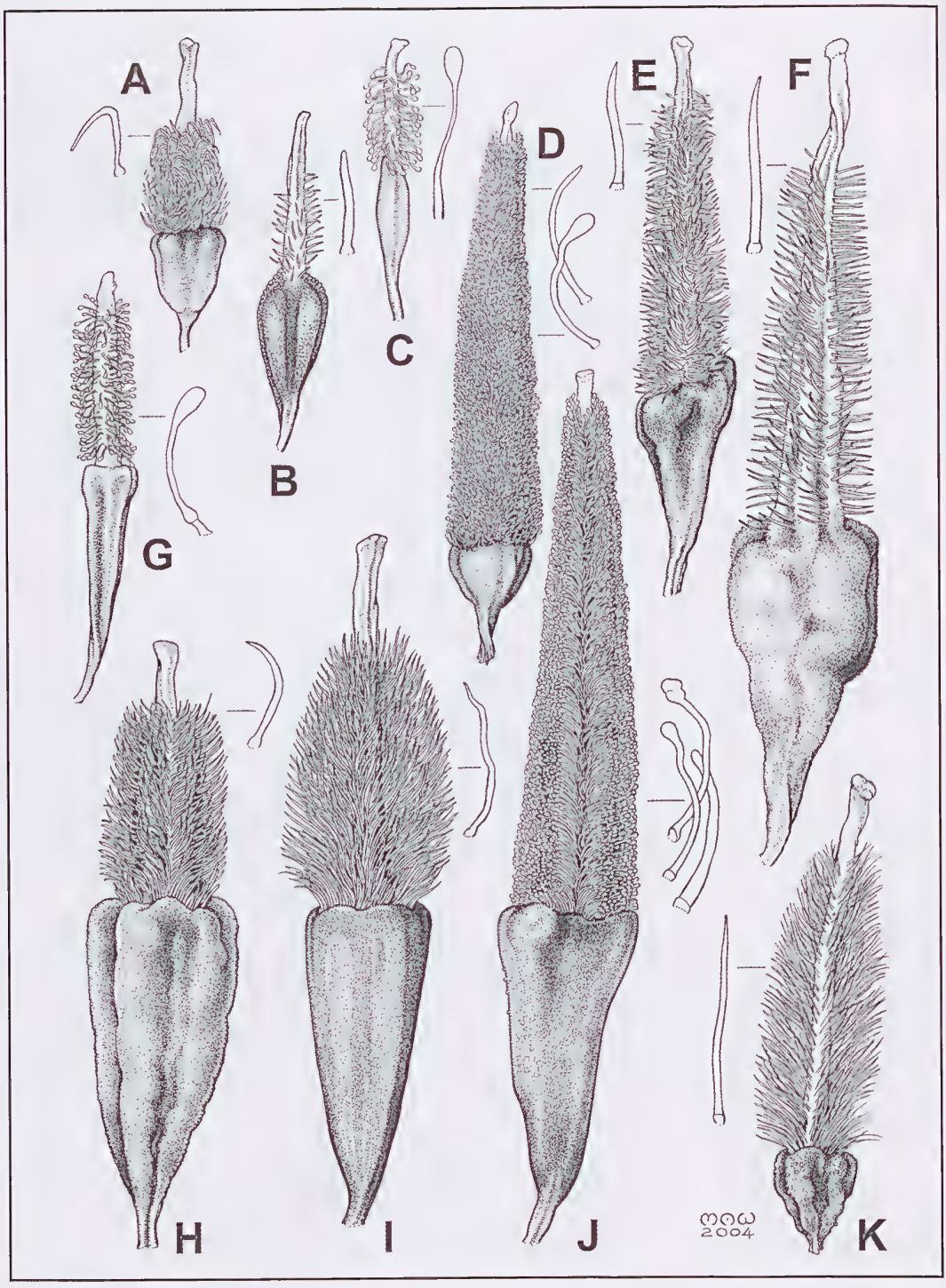

Figure 1. Pollen presenters with representative hairs enlarged. A – *P. acicularis*; B – *P. anceps*; C – *P. antecedans*; D – *P. aspera*; E, F – *P. brevifolia* complex; G – *P. clavata*; H – *P. filifolia* subsp. *filifolia*; I – *P. filifolia* subsp. *laxa*; J – *P. helicophylla*; K – *P. juncifolia*. Drawn by M. Wilson from *G.J. Keighery* 12175 (A), *T.E.H. Aplin* 2076 (B), *F. Hort* 1044 (C), *D.B. Foreman* 1125 (D), *P. Fairall* 2188 (E), *F. Hort & J. Hort* 1860 (F), *L. Polomka & S. Patrick* 4147 (G), *G.J. Keighery* 6717 (H), *F. Hort & J. Hort* 2097 (I), *F.H. Mollemans* 4401 (J) and *R. Davis* 4453 (K).

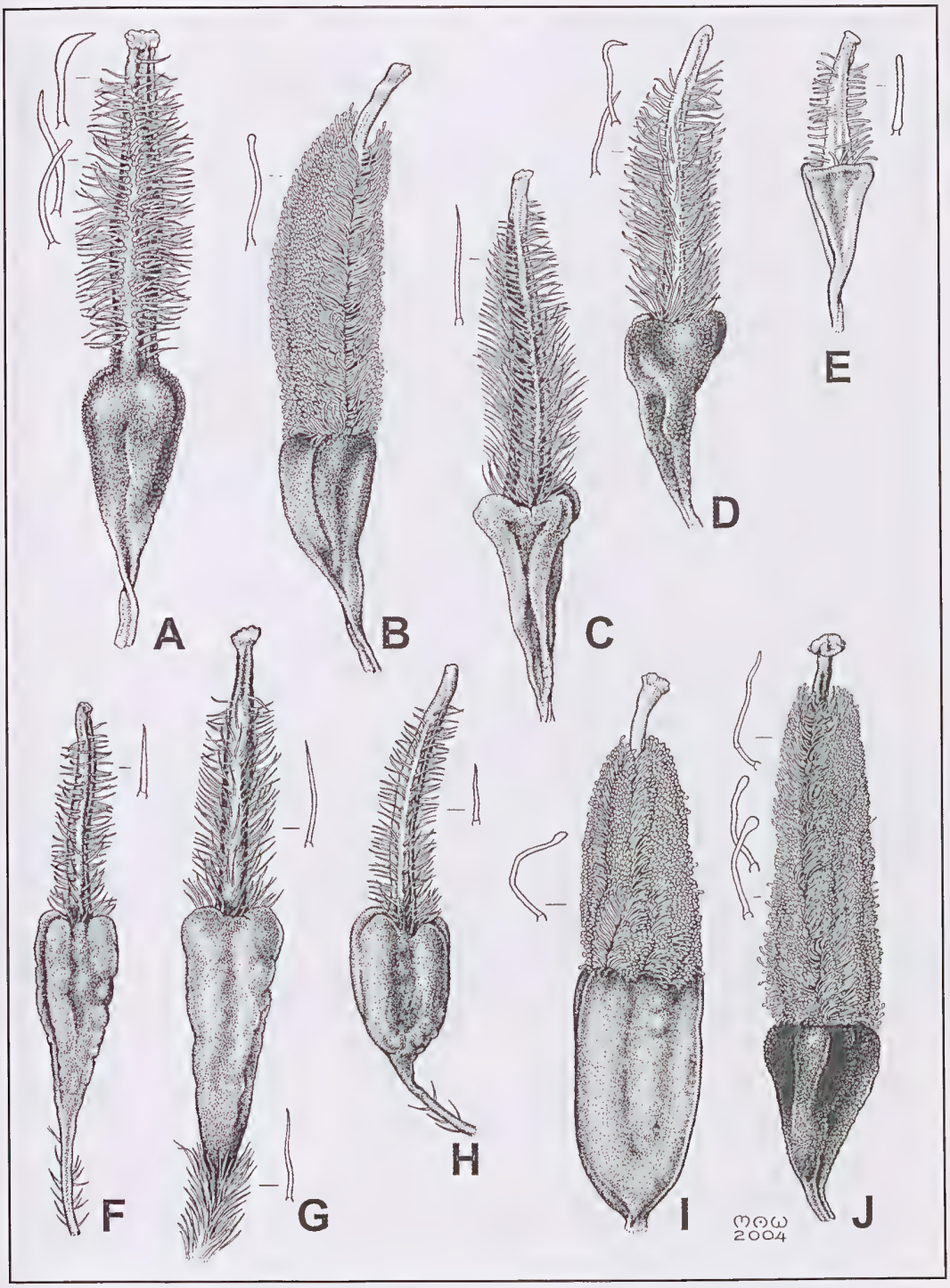

Figure 2. Pollen presenters with representative hairs enlarged. A – *P. linearis*; B – *P. longifolia*; C – *P. media*; D – *P. megalostegia*; E – *P. nivea*; F – *P. pilostyla* subsp. *austrina*; G – *P. pilostyla* subsp. *pilostyla*; H – *P. pilostyla* subsp. *syntoma*; I – *P. prostrata*; J – *P. teretifolia*. Drawn by M. Wilson from *S. Turner* 154 (A), *M. Hislop* 3086A (B), *A.R. Annels* 4115 (C), *B.J. Conn* 2062 (D), *M. Hislop* 2261 (E), *D.B. Foreman* 544 (F), *A.S. George* 9586 (G), *G. Stapp* 96 (H), *J.W. Horn & R. Butcher* 2649 (I) and *D.B. Foreman* 1432 (J).

Petrophile pilostyla Rye & Hislop, *sp. nov.*

Petrophile brevifoliae affinis sed bracteis involucri minus distincte bicoloribus, pollinis praebitor pilis tenuibis et axe gracilissimo, stylo piloso differt.

Typus: c. 0.5 km south of Binnu East Rd on Mongeragarry Rd, Western Australia, 19 Aug. 2003, *B.L. Rye* 238037 *& M.E. Trudgen*, (*holo:* PERTH 06744095; *iso:* K, MEL).

Illustration. Foreman (1995: Figure 94A) [as *Petrophile brevifolia*].

Shrubs single-stemmed at the base or becoming branched near or at ground level, 0.4–1.7(2) m high. *Branchlets* prominently ribbed, grey, glabrous. *Leaves* mostly spreading, not crowded, terete, straight to strongly curved or somewhat s-shaped, 40–110 mm long, 1–1.5 mm diam., glabrous; point pungent, 2–3 mm long. *Flower heads* terminating branchlets and also at lower junctions where the branchlets arise and then often appearing lateral, sessile, globose, usually 22–35 mm diam., occasionally appearing to be up to 50 mm wide when several heads are very closely associated. *Involucral bracts* few to numerous, erect, mostly narrowly ovate, 5–12 mm long, acuminate, glabrous, the inner ones pale brown either throughout or basally and grading into grey above, the outer ones usually grey thoughout or with brown restricted to the base. *Cone scales* almost elliptic to broadly obovate, 3–5 x 2.2–3.5 mm, acute, brown, longitudinally ribbed, glabrous outside or occasionally with a few hairs along the midrib, glabrous to densely ciliate on margins; ribs 7 or more at base, sometimes inconspicuous in flowering stage, becoming very prominent and tending to branch towards the thickened summit of the persistent portion; cilia 0.1–0.4 mm long. *Tepals* 9.5–17 mm long; claw cream or pale yellow, glabrous at base, with a very dense indumentum above of widely antrorse to patent hairs; limb 3.2–4.5 mm long, pale brownish or greyish, very densely antrorse-hairy outside, the hairs 0.2–0.4 mm long. *Anthers* 1.6–2.5 mm long. *Style* usually hairy, 0.3–0.8 mm long. *Pollen presenter* 3.5–5.5 mm long, deep yellow turning orange or sometimes reddish; base 1.5–3 x 1–1.5(1.7) mm, 4-lobed, sometimes with a few hairs towards the bottom and/or on the truncate summit; brush moderately dense (the axis visible), 2–3 mm long, 0.4–0.6 mm diam., with a slender cylindrical axis and numerous very fine patent or widely antrorse acute hairs 0.15–0.3 mm long; glabrous apical tip 0.3–0.5 mm long. *Cones* depressed globose or globose, 10–16 x 10–20 mm; scales broad, up to 15-ribbed. *Nuts* very broadly elliptic to depressed obovate (usually very broadly obovate) in outline, 2–3.5 x 2.5–3.5 mm not including style base, the attached base of the style often forming a long point; abaxial surface dark brown with paler margins, with appressed to closely antrose hairs 0.5–1 mm long very densely arranged along the middle and more scattered or largely absent elsewhere; adaxial surface with large golden brown hairs throughout and sometimes also a few much shorter dark purplish hairs towards the base, the largest marginal hairs 3–4.5 mm long forming a prominent coma.

Distribution. Extends from Tamala Station south-east to near Watheroo National Park, but with a disjunction of over 100 km in the known range of the species.

Phenology. Flowers mainly July to early September but also recorded as late as early October. Mature nuts measured on the type of subsp. *syntoma* and several specimens of each of the other two subspecies.

Etymology. From the Latin *pilus* –hair and *stylus* – style, as this species is the only member of *Petrophile* section *Arthrostigma* to have the style usually distinctly hairy. Species with hairy styles do occur in sections *Xerostole* (Endl.) Benth. and *Serrurioides* Benth.

Affinities. This species is usually readily distinguished from all other species in sect. *Arthrostigma* by

its distinctly hairy style, although there are a few specimens of one subspecies in which the style hairs are few or absent. It was previously included within the very broad circumscription of its close relative *Petrophile brevifolia*, but can be readily distinguished by its less distinctly bicoloured involucral bracts, which have intergrading brownish and grey portions or are brownish throughout. In *P. brevifolia*, the involucral bracts are generally more subulate and have a brown midrib contrasting strongly with the grey margins, although this distinctive bicoloured appearance may fade to a more uniform grey when the bracts age.

Flower colour in *P. pilostyla* is cream or very pale yellow, whereas *P. brevifolia* has pale to bright yellow flowers, or much less commonly, pale pink flowers. The as yet undescribed taxon *P. latericola s. lat.* (see discussion on page 473), commonly has very pale or pale yellow flowers, overlapping considerably with the flower colours of the other two taxa.

Petrophile pilostyla always has a slender axis and fine hairs on the pollen presenter brush, unlike true *P. brevifolia*, which has a thicker and often tapering axis to the brush and coarser hairs. *P. latericola s. lat.* is intermediate between these two taxa in its pollen presenter, showing some overlap with *P. pilostyla* but tending to have a paler base and nearly always with a broader and/or sparser brush. *P. pilostyla* is distinguished from both taxa, however, in its smoother enlarged base to the pollen presenter. In the other two taxa, the base is minutely but distinctly papillose. The top of the expanded base of the pollen presenter in *P. pilostyla* bulges upwards to enclose the base of the brush, resulting in the basal hairs of the brush being forced into an antrorse orientation. In the *P. brevifolia* complex the expanded base is more truncate or tapers at the top and there is sometimes a distinct gap between it and the base of the brush so that the brush hairs are generally all patent.

Differences in flowering time have been observed between *Petrophile pilostyla* and its closest relatives in the Warradage area, where they occur in close proximity. In that area, *P. pilostyla* subsp. *austrina* (*M. Hislop* 1355) commenced flowering first but overlapped in flowering time with *P. latericola s. lat.* (*M. Hislop* 2743), with typical *P. brevifolia* (*M. Hislop* 1781) coming into flower after both of the other species had finished. Although at this locality plants of *P. pilostyla* and *P. latericola s. lat.* grow side by side, no hybrids or intergrades have been observed there, nor have they been observed at any other localities.

Notes. There is considerable morphological variation in *Petrophile pilostyla*, with three main variants that are all geographically distinct. These variants show minor but significant differences in their morphology and are treated here as subspecies.

a. Petrophile pilostyla subsp. **austrina** Rye & Hislop, *subsp. nov.*

A subspecies typica squamis strobili plus ciliatis, distributio magis australi differt.

Typus: 'Big soak plain', south of Alexander Morrison National Park, 30°7'36"S, 115°32'30"E, Western Australia, 25 August 2002, *M. Hislop* 2726, *F. & J. Hort and D. & J. Williams* (*holo:* PERTH 05423708; *iso:* K, MEL).

Shrubs probably not fire-tolerant, 0.4–1 m high. *Leaves* 35–65 mm long; point 1–2.5 mm long. *Flower heads* 22–35 mm diam. *Cone scales* often with a few hairs along the midrib, glabrous to densely ciliate on margins; longest cilia 0.25–0.4 mm long. *Tepals* 10.5–18 mm long. *Anthers* 1.6–2.5 mm long. *Style* sparsely to moderately densely hairy in basal half or up to base of pollen presenter or very rarely glabrous;

indumentum 0.25–0.4 mm long. *Pollen presenter* 3.5–4.5 mm long, much shorter than the remainder of the style; base 1.5–2.2 mm long; brush 2–2.5 mm long. (Figure 2F)

Selected specimens examined. WESTERN AUSTRALIA: 2.9 km along road 40 from Carnamah–Eneabba road, 18 Sep. 1991, *R.J. Cranfield & P. Spencer* 8069 (PERTH); 3 km N of Mungedar turnoff on Badgingarra road, 31 Aug. 1984, *D.B. Foreman* 418 (PERTH); Marchagee Track, *c.* 27 km E of Brand Highway, 1 Sep. 1984, *D.B. Foreman* 480 (PERTH); on Carnamah road, 14 km E of Eneabba, 4 Sep. 1984, *D.B. Foreman* 524 (PERTH); on private farmland off Green Head–Coorow road, *c.* 3 km W of Brand Highway, 30 July 1995, *M. Hislop* 59 (PERTH); Hi Vallee (property of D. & J. Williams), near Warradarge, upland to north of main valley, 10 July 1999, *M. Hislop* 1355 (PERTH); in SW corner of Watheroo National Park, 6 Oct. 1971, *R.D. Royce* 9619 (PERTH); Tootbardi Rd, 2.1 km E of Brand Highway, 18 Aug. 2003, *B.L. Rye* 238006 & *M.E. Trudgen* (PERTH).

Distribution and habitat. Extends from the Eneabba area south to Badgingarra and inland to near Watheroo National Park. Recorded in low to tall shrublands on low hills and other somewhat elevated sites, mainly in white or yellow sand, often with lateritic gravel or over laterite, but some populations on grey sand. The shrublands tend to be rich in members of the Proteaceae, often with *Banksia* species dominant, but sometimes dominated by eucalypts such as *Eucalyptus todtiana*.

Etymology. From the Latin *australis* – southern, as this subspecies has a disjunct distribution south of the remainder of the species range.

Notes. This subspecies has shorter leaves on average than the other two subspecies. A specimen from Watheroo National Park (*R.D. Royce* 9619) has particularly short tepals 10.5–11 mm long, similar in size to those of subsp. *syntoma*, but its mature style is still much longer than the pollen presenter. The style is always at least sparsely hairy in the basal half in most populations but a few specimens (e.g. *D.B. Foreman* 418, *M. Hislop* 59) in the far east or south of the species range have a glabrous or very sparsely hairy style.

b. Petrophile pilostyla Rye & Hislop subsp. **pilostyla**

Shrubs with a stout basal stem that is probably somewhat fire-tolerant, 0.5–1.7(2) m high. *Leaves* 40–100 mm long; point 2–3 mm long. *Cone scales* glabrous or rarely with a few hairs along the middle outside, glabrous or ciliate on upper margins; longest cilia 0.1–0.25 mm long. *Tepals* 12–16 mm long. *Anthers* 2.2–2.5 mm long. *Style* moderately densely to densely hairy in basal half and usually for its full length up to base of pollen presenter; indumentum 0.3–0.6 mm long. *Pollen presenter* 4–5 mm long, much shorter than the remainder of the style; base 1.5–2.5 mm long; brush 2–2.5 mm long. (Figure 2G)

Selected specimens examined. WESTERN AUSTRALIA: Kirralee Farm, Brooke Rd, Ajana, 10 km E of North West Coastal Highway, 27 Aug. 2001, *G. & P. Allan* 55 (PERTH); Loop Rd, Kalbarri, 1 Aug. 1987, *D. & B. Bellairs* 1746 (PERTH); 22 km N of Yuna on the Dairy Creek–Gascoyne Junction road, 10 Sep. 1984, *D.B. Foreman* 638a (PERTH); 16 miles [26 km] SSE of Tamala Station Homestead, 27 Aug. 1969, *A.S. George* 9586 (PERTH); 6.5 km E on road from intersection with North West Coastal Highway, 1 km N of Binnu Railway Siding, 26 Sep. 1985, *N. Hoyle* 459 (PERTH); Zuytdorp National Park, 0.2 km from track that parallels coast from State Barrier Fence on track to Zuytdorp wreck site, 18 Aug. 1995, *G.J. Keighery & N. Gibson* 999 (PERTH); *c.* 1 km NE of Howatharra Hill Reserve, Moresby Range, 27 Aug. 1977, *N. McFarland & A. Weston* 1236 (PERTH); *c.* 0.5 km S of Binnu East Rd on Mongeragarry Rd, 19 Aug. 2003, *B.L. Rye* 238036 & *M.E. Trudgen* (PERTH).

Distribution and habitat. Extends from Tamala Station southwards in near-coastal areas to Moresby Range and inland (south-east) to the Yuna area. Recorded in low to tall shrublands, commonly on low hills and other somewhat elevated sites, mainly in white or yellow sand, often with lateritic gravel or over laterite, but the northernmost populations (Tamala area) in sand over limestone. The shrublands tend to be rich in members of the Proteaceae, often with *Banksia* species dominant, but sometimes dominated by eucalypts or *Actinostrobus arenarius*.

Notes. The typical subspecies has a considerably larger range than the other two subspecies, extending from Tamala Station to Moresby Range and East Yuna Nature Reserve. It tends to be a more robust and often taller shrub, up to about two metres high, with a thick base that appears to be fire-tolerant; however the tolerance to fire of all three subspecies needs to be investigated further. Its upper cones scales are commonly glabrous, whereas those of the other two subspecies are always ciliate, and when cilia are present in subsp. *pilostyla* they are short.

c. Petrophile pilostyla subsp. **syntoma** Rye & Hislop, *subsp. nov.*

A subspeciebus ceteris stylo breviore magis piloso, pollinis praebitor stylum reliquum aequans vel vix superanti.

Typus: Indarra Springs Reserve, along track from spring to eastern boundary, Western Australia, 26 September 1998, *G. Stapp* 172 (*holo:* PERTH 05775337).

Shrubs 0.5–1 m high, sometimes wider than high, with basal stem slender as far as known but largely buried so possibly somewhat fire-tolerant. *Leaves* 55–110 mm long; point 2–2.5 mm long. *Cone scales* often hairy along the middle outside, densely ciliate on upper margins; longest cilia 0.25–0.35 mm long. *Tepals* 9.5–12.5 mm long. *Anthers c.* 2.5 mm long. *Style* densely hairy; indumentum 0.6–0.8 mm long. *Pollen presenter* 4.5–5.5 mm long, about as long as or slightly shorter than the remainder of the style; base 2–3 mm long; brush 2.5–3 mm long. (Figure 2H)

Other specimens examined. WESTERN AUSTRALIA: 4 miles [6.4 km] W of Indarra, 27 Aug. 1965, *K.R. Newbey* 2160 (PERTH); Indarra Springs Nature Reserve, on Moore Rd, 10.4 km S of Geraldton–Mount Magnet road, 22 Aug. 2003, *B.L. Rye* 238109 *& M.E. Trudgen* (MEL, PERTH); Indarra Springs Reserve, along track to spring, 16 Sep. 1998, *G. Stapp* 96 (PERTH).

Distribution and habitat. Recorded near Indarra and in Indarra Springs Reserve (south of Mullewa). The most recent collection cited above was from the crest of a large sand dune, with bright yellow sand, the vegetation of scattered *Xylomelum* low trees over *Banksia* high shrubland. There are two other records of the subspecies occurring in yellow sand, at one location apparently occurring with *Allocasuarina campestris*.

Conservation status. Conservation Codes for Western Australian Flora: Priority Two. Subsp. *syntoma* appears to be very geographically restricted and may be endangered. At the most recent collection site for the taxon, about six dead plants were observed along the top of the crest of a sand dune, apparently killed by the drought conditions of the previous two years. A single surviving, but still drought-stressed, plant was found in a slightly more moist location a little below the top of the crest.

Etymology. From the Latin *syntomos* – shortened, referring to the short style.

Notes. Subsp. *syntoma* differs from the other two subspecies in its usually shorter tepals and always in its particularly short and very hairy style, the style indumentum both denser and longer than in the other two subspecies. Its pollen presenter is also longer on average and about the same length as the remainder of the style or not a great deal shorter. Subsp. *syntoma* is more like the southern subspecies in its densely ciliate cone scales but more like the typical subspecies in its long leaves.

There are not enough records to be sure of the habit and height range in subsp. *syntoma*, but the specimen collected during this study was a domed fairly dense shrub 0.55 m high and 0.8 m across. It had a basal stem *c.* 40 mm diam. buried in the sand and widening at ground level where it split into three main branches, two of them prostrate and the central one erect.

Petrophile prostrata Rye & Hislop, *sp. nov.*

Petrophile longifoliae affinis sed habito perfecte prostrato, foliis secundis et plerumque floribis grandioribus, coma in nuce longiore differt.

Typus: Collets Rd, 0.45 km west of Qualup Homestead Rd, Fitzgerald River National Park, Western Australia, 28 September 1999, *J.W. Horn & R. Butcher* 2649 (*holo:* PERTH 05645670; *iso:* DUKE *n.v.*)

Illustration. Foreman (1995: Figure 29).

Prostrate *shrub* 0.2–0.3 m high, with its height being equivalent to the length of its erect leaves, single-stemmed at the base at first as a small erect plant but soon dividing at ground level into multiple prostrate branches that are usually partially to fully covered by sand and spreading to a radius (or irregular width) commonly of 0.4–1 m diam. *Branchlets* glabrous, often bright red at first, usually soon distinctly irregularly ribbed and very dark red-brown, becoming more grey with age. *Leaves* sometimes crowded, erect and to one side of the stems and congregated to one side of each flower head, terete, often straight or fairly straight, less frequently gently to strongly curved, 200–320 mm long, 1–2 mm diam., glabrous; apex a dark, blunt or coarsely pungent, slightly uncinate mucro to 1.5 mm long. *Flower heads* terminating branchlets, horizontal to erect, usually at least semi-erect, sometimes separated from the leaves by a horizontal stem with moderately distant bracts, globose, (30)35–55 mm diam., the upper bracts short and broad. *Involucral bracts* often scattered along the stems for some distance below each inflorescence, ovate or broadly ovate, acuminate, glabrous, dark brown. *Cone scales* broadly to depressed ovate, 5–9 x 6–9 mm, acute to acuminate, glabrous, dark red-brown to very dark brown, not or faintly ribbed, apex sometimes becoming recurved. *Tepals* 18–27 mm long, cream or pale yellow throughout; claw glabrous at base, densely hairy above with an indumentum of widely antrorse to patent hairs; limb 5–7 mm long, densely hairy, the hairs antrorse and *c.* 0.5 mm long. *Anthers* 2–3 mm long. *Style* red and glabrous except for the pollen presenter brush. *Pollen presenter* 4–5.5 mm; base 1.5–2.2 x 1–1.3 mm, angular and often distinctly flattened, with 4–8 more or less prominent longitudinal ribs (often somewhat compressed on one surface and more ribbed on the other), deep yellow turning orange; brush very dense, 2–3.5 mm long (including glabrous tip), 0.9–1.2 mm diam., the axis totally concealed by the patent or widely antrorse, incurved and clavate hairs 0.3–0.4 mm long, that so crowd the truncate apex of the base as to form the appearance of a solid outline between base and brush. *Cones* mostly very broadly or depressed ovoid and 15–25 x 15–25 mm; scales dark brown, with upper portion clearly demarcated at maturity. *Nuts* broadly ovate to very broadly obovate, 3–4.5 x 2–3.5 mm including the acute persistent style base; the abaxial surface usually glabrous but occasionally with a few antrorse hairs on the persistent style base,

brown and often with 2 darker, elliptic markings on either side of the medial line; the adaxial surface densely covered by very short dark purple hairs overtopped by a moderately dense to sparse layer of golden-brown antrorse hairs commonly 2–3 mm long, with similar but larger hairs 4–6 mm long concentrated close to the margins to form a conspicuous coma. (Figure 2I)

Selected specimens examined. WESTERN AUSTRALIA: between Bremer Bay and Gordon Inlet, 3 Oct. 1981, *M.G. Corrick* 7774 (NSW, PERTH); just past Lake Magenta Rd, 75 km W of Ravensthorpe, 4 Nov. 1978, *R.J. Cranfield* 1002 (NSW, PERTH); Fitzgerald River National Park, 19.25 km SE of ranger's station on Quiss Rd, 6 Oct. 1988, *J.M. Fox* 88/198 (PERTH); between Hamersley River and East Mt Barren, 30 Sep. 1970, *B.R. Maslin* 871, 880 (PERTH); near Mt Groper in Reserve 14986, Cheyne Bay, N of Cape Riche, 28 Sep. 1996, *J.W. Mercer* 92 (PERTH); Hamersley Drive, 6.45 km NW of Moir Track, 9 Dec. 2003, *B.L. Rye* 231216 (PERTH).

Distribution and habitat. Extends from Jerramungup and the upper Corackerup Creek south to Mt Groper and south-east to near Hopetoun, including many localities in Fitzgerald River National Park. Occurs on white or grey sandy soils that are sometimes associated with laterite, granite or limestone, in low open heathlands or mallee shrublands and other shrublands, the dominant species often including *Banksia*, *Eucalyptus* and *Hakea* species. The most recent collection cited above was made from the summit of a broad rise, with scattered mallees over an extremely rich low shrubland/heathland with many Proteaceae species (including *Adenanthos*, *Grevillea*, *Isopogon* and *Petrophile*), Myrtaceae (including *Beaufortia*, *Melaleuca* and *Verticordia*), Epacridaceae, *Hibbertia*, *Boronia* and other shrub species over sedges.

Phenology. Flowers mainly from late August to mid November. Nuts measured on a number of specimens including *H. Demarz* 1090, *A.S. George* 10926 and *B.R. Maslin* 1007.

Affinities and notes. This taxon has been known by the informal name *Petrophile* sp. prostrate (*J.W. Horn & R. Butcher* 2649). A strictly prostrate growth habit is the main character separating it from *P. longifolia*. Both taxa have a single-stemmed base; this tends in *P. longifolia* to branch rapidly and semi-erectly, producing multiple erect flower heads over a fairly short distance, whereas in the new taxon the branching tends to be more distant and more divaricate with all stems strictly prostrate and the flower heads borne on the ground. On herbarium specimens the difference in habit is usually obvious, although the usually divaricate nature of the branching in *P. prostrata* can be hidden by the pressing process. The most reliable way to distinguish the two taxa from herbarium specimens is by the orientation and arrangement of the leaves adjacent to the flower heads as these surround the heads in *P. longifolia* but are concentrated to one side of the heads in *P. prostrata*.

No other complete differences between the two taxa have been confirmed, although the inflorescence and tepals of *P. prostrata* are usually larger and the cone scales are usually broader than in *P. longifolia*. The pollen presenter tends to be larger, with the base nearly always longer, and its brush hairs tend to be more obviously clubbed, but there are no absolute differences. Nuts are commonly present on specimens of *P. prostrata* but difficult to find on specimens of *P. longifolia*, and the coma on the nut is nearly always longer in *P. prostrata* than in *P. longifolia*.

A single seedling (*B.R. Maslin* 880) is represented among the herbarium specimens of this species. It is notable in its erect habit, in marked contrast to the mature plants occurring in the same population (*B.R. Maslin* 871). This seedling, on its own, would not be identifiable as the new taxon and suggests a closer relationship between this new taxon and typical *P. longifolia* than would appear to be the case

based on the very distinctive habit of the mature plants.

The distribution of *P. prostrata* is mainly to the east of that of *P. longifolia* but the two taxa overlap slightly in range, with both occurring in the Cheyne Bay area south-east of Wellstead (*J.W. Mercer* 91 & 92), where they appear to maintain their distinctiveness.

Table 1. Comparison of the morphology of the pollen presenter in the members of *Petrophile* sect. *Arthrostigma* (all measurements in millimetres).

Taxon	Pollen presenter length			Brush diameter	Hair length	Hair orientation and apex
	base	brush	total			
P. acicularis	0.5–0.7	1.5–2	2–2.5	0.5–0.7	0.2–0.4	recurved at apex, acute
P. anceps	1.3–2.8	2–2.8	3.2–5.4	0.5–0.7	0.15–0.2	patent, obtuse, straight
P. antecedens	0.5–0.8	0.8–1.2	1.5–2.2	0.5–0.7	0.2–0.3	patent, distinctly clubbed, straight
P. aspera	0.5–1	3.4–4.8	4–5.5	0.8–1	0.3–0.5	patent or widely antrorse, clubbed, incurved
P. brevifolia	1–3	2–3.1	3–6	0.7–1.3	0.25–0.5	patent or widely antrorse, acute, straight
P. clavata	1.3–2.3	1–1.5	3–3.6	0.6–0.7	0.2–0.3	patent, distinctly clubbed, straight
P. filifolia	1–2.2	2.5–3.2	3.6–5.5	0.8–1.3	0.3–0.8	patent to antrorse*, acute or obtuse, mostly incurved
P. helicophylla	1.8–2.2	4.3–5.1	6.3–7.5	1–1.2	0.3–0.4	patent, clubbed, incurved
P. juncifolia	0.8–1.8	2.4–3.5	3.2–5	1–1.4	0.5–0.7	antrorse or widely so, acute, straight
P. latericola ms.	1.1–2.2	0.9–2.5	3–4.5	0.4–0.9	0.15–0.4	patent or widely antrorse, acute, straight
P. linearis	1.6–2.7	2.1–3	4–6.2	0.8–1.4	0.3–0.5	patent, acute, straight
P. longifolia	0.9–1.4	1.9–2.7	3–4.4	0.8–1.1	0.3–0.5	patent or widely antrorse, mostly clubbed, incurved
P. media	1–2	2–3	3–5	0.6–1	0.3–0.45	widely antrorse or patent, acute, straight
P. megalostegia	1–1.8	2–3.2	3.5–4.8	0.8–1.3	0.3–0.5	more or less patent, acute, straight
P. nivea	1–1.3	1–1.3	2–2.8	*c.* 0.5	*c.* 0.2	patent, acute, straight
P. pilostyla	1.5–3	1.6–3	3.5–5.5	0.4–0.6	0.15–0.3	patent or widely antrorse, acute, straight
P. prostrata	1.4–2.5	2.2–3.5	3.5–5.5	0.9–1.2	0.3–0.4	patent or widely antrorse, clubbed, incurved
P. teretifolia	0.8–1.5	3–4	4–5.5	0.8–1	0.3–0.4	patent, mostly clubbed, incurved

* basal hairs more antrorse and straighter than other hairs.

Acknowledgements

We are grateful for the loan of specimens, mostly types, from BM and MEL, a photocopy of a type from CGE, and for permission to examine material at NSW. We also thank Paul Wilson for advice on nomenclature and the Latin diagnoses, Margaret Wilson for the illustrations, and Fred Hort and Malcolm Trudgen for their contributions to the field work carried out in the study.

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A new heterocarpidic fruit type for the Myrtaceae, with dehiscent and indehiscent loculi, in two genera from Western Australia

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Abstract

Rye, B.L. and Trudgen, M.E. A new heterocarpidic fruit type for the Myrtaceae, with dehiscent and indehiscent loculi, in two genera from Western Australia. *Nuytsia* 15(3): 485–493 (2005). A form of heterocarpidy with dehiscent and indehiscent loculi present in the same fruit is described from species in two genera of Myrtaceae occurring in the south-west of Western Australia. This extreme development of heterocarpidy results in a very unusual fruit type, one that has not previously been described for the Myrtaceae. It is also apparently rare in the angiosperms, although smaller differences between carpels (mostly in their size and the number of seeds) are not uncommon. In *Astus* Trudgen & Rye and the *Baeckea robusta* F. Muell. complex, two types of ovary loculi develop, with one type dehiscent by a suture on the floral disc and the other type lower in the ovary and indehiscent. The occurrence of this heterocarpidic fruit type in two fairly different genera is considered to be a convergent development rather than indicating a particularly close relationship. The heterocarpidic fruit in these groups is described and illustrated, and its adaptive and taxonomic significance discussed.

Introduction

A very unusual fruit type, which has both dehiscent and indehiscent carpels, is reported from two genera of Myrtaceae occurring in the south-west of Western Australia. This fruit type is an extreme example of heterocarpidy – the differential development of loculi within the same ovary. It occurs in the new genus *Astus* Trudgen & Rye (Trudgen & Rye 2005) and also in the *Baeckea robusta* F. Muell. species complex, and its occurrence in these genera is the first record of such a fruit for the Myrtaceae.

The heterocarpidic fruit described from *Astus* and *Baeckea robusta* and its allies is a remarkable phenomenon that demonstrates a significant plasticity in the fruit of at least some Myrtaceae. The development and survival of this fruit type in two groups raises significant questions with respect to the comparative advantages of fully dehiscent, fully indehiscent and heterocarpidic fruits in Australian Myrtaceae. The heterocarpidic fruit type probably has advantages for seed dispersal and survival and also has implications for the understanding of the importance of fruit types in classification within the Myrtaceae.

In Niedenzu's (1893) classification, the family Myrtaceae is divided into the fleshy-fruited subfamily Myrtoideae and the dry-fruited subfamily Leptospermoideae, with the latter subfamily subdivided into the tribe Leptospermeae with a capsular fruit and the tribe Chamelaucieae with a nut. While the fleshy-

fruited taxa are pantropical, the dry-fruited ones (with the exception of the subtribe Metrosiderinae) are primarily distributed in Australasia and predominantly occur in temperate and arid climates. In contrast to this correlation between climatic zones and the distributions of the subfamilies, the tribes Chamelaucieae and Leptospermeae have similar distributions, even having about the same proportion of species occurring in the arid zone (Rye & James 1992).

Separation of the tribe Chamelaucieae purely on the basis of its having a nut has long been considered problematical. In fact Bentham (1867: 5) noted that some members of one of the subtribes of the Chamelaucieae "pass so gradually into the Leptospermeae, as only to be distinguishable from *Baeckea* by the examination of the ovary". Briggs & Johnson (1984) combined the Chamelaucieae with the subtribe Baeckeinae of the Leptospermeae to form an informal *Chamelaucium* alliance, which they considered to include a number of separate lineages in which capsular groups have given rise to taxa with nuts. For example, the unilocular genus *Malleostemon* J.W. Green shows a much closer similarity in its morphology, particularly in its anther type, to some of the multilocular genera, such as *Babingtonia* Lindl. and *Scholtzia* Schauer, than it does to other unilocular genera of the alliance. Molecular analyses of DNA samples (Lam *et al.* 2002) provide independent evidence that *Malleostemon* is closely related to *Babingtonia* and *Scholtzia*. A broader (compared to Bentham) circumscription of the tribe Chamelaucieae has recently been formally published (Wilson *et al.* 2005), with limits the same as that of the Chamelaucium alliance of Briggs & Johnson.

As outlined above, the major divisions of the Myrtaceae have traditionally been based on fruit type. Consequently, the heterocarpidic fruit described here is of particular interest as it is another example of the ability of groups in the Myrtaceae to change their fruit loculi from dehiscent to indehiscent, adding to our understanding of the evolution of fruits in this family. It is possible that the change to an indehiscent fruit from a fully dehiscent capsule in some other groups of the Myrtaceae has involved an intermediate stage where there was a heterocarpidic fruit similar to that described here.

Fruit types found in the Leptospermoideae

The most common fruit type found in the Leptospermoideae* is a crustaceous to woody capsule with loculicidal dehiscence of its 2–5, or more, loculi. The other common type is a unilocular indehiscent fruit that is usually one-seeded and which is appropriately described as a nut (Roth 1977: 244; Rye & James 1992) even when more than one-seeded. However, in a small proportion of the species and genera of Leptospermoideae the fruit is intermediate between these two fruit types, in that it is multilocular and indehiscent. This type of fruit is found, for example, in all members of *Enekbatus* Trudgen & Rye ms. and *Scholtzia*.

Another fruit type found in the Leptospermoideae that is intermediate between the capsule and the nut, is the heterocarpidic fruit described in this paper from species in two genera. This fruit type is much rarer in the Myrtaceae and is currently known from only eight species. It is especially interesting since there seem to be very few records of such fruits in the literature, although lesser differentiation between loculi (e.g. reduction in ovule number) is relatively common (Roth 1977). The only published indication of this fruit type in south-western Australian Myrtaceae was the observation made by Rye (1987) that one loculus was situated at a somewhat lower level than the other two loculi in the ovary of *Baeckea robusta* F. Muell.

*No longer recognised in the recent classification of Wilson *et al.* (2005), subfamily Leptospermoideae is not a natural group but is used here for convenience to refer to the dry-fruited Myrtaceae as a whole.

Terminology

Roth (1977) and Spjut (1994) have both carried out extensive reviews of fruit types, with Roth emphasising the anatomy of angiosperm fruits and Spjut attempting to provide a systematic means for recognising fruit types and a strict terminology for them. Roth (pp. 591, 598) very briefly discusses heterocarpidy, which she describes as a "different development of the carpels composing the coenocarpous gynoecium" that is usually expressed in carpel reduction or reduction in the number of seeds, frequently with one or several underdeveloped carpels either being sterile or having a reduced number of seeds. Roth attributes the term to Stopp (1962), whose work included a description of this phenomenon in the South African genus *Rogeria* (Pedaliaceae). In *Rogeria bigibbosa* and *R. adenophylla* "the abaxially situated carpel is favoured in its development and contains more seeds than the reduced one, the latter being indehiscent, while the favoured carpel dehisces" (Roth 1977: 598). This is the only example Roth gives that resembles the fruit type described here for the Myrtaceae in having a combination of dehiscent and indehiscent fertile loculi.

In Spjut's (1994) extensive classification of fruits, a very large number of specific terms are described in detail, many of them based on the mode of dehiscence. However, his key has no provision for fruit types that have both dehiscent and indehiscent loculi, and he does not mention heterocarpidy, nor refer to the genus *Rogeria*. In fact, he does not have specific terms for any of the dry fruit types that have evolved from the Myrtaceous capsule, i.e. the multilocular indehiscent fruit, the unilocular indehiscent fruit referred to here as a nut, and the partly indehiscent capsule.

We suggest that the fruit type of *Astus* species and of members of the *Baeckea robusta* complex is best described as an extreme case of heterocarpidy that results in a fruit with dual functions. It functions partly as a capsule and partly as an indehiscent fruit. As far as we can ascertain, there is no accepted name for such a fruit, although it can be described as a *heterocarpidic capsule with one or sometimes two indehiscent loculi*, or more simply as a *partly indehiscent capsule*. For convenience, we will use the latter phrase in this paper.

We do not propose a new term here for the partly indehiscent capsule. It would be better for this to be done in a critical review of terminology for all fruit types in the Myrtaceae. Such a study should pay particular attention to the large variation in the capsule, and ideally would involve sufficient anatomical work to define the varying roles of different tissues in each of the fruit types.

Morphology of the partly indehiscent capsule

Roth (1977: 591) has observed that heterocarpidy "is widespread in the plant kingdom, especially in flowers with dorsiventral symmetry". An interesting aspect of the development of the partly indehiscent capsule in the Myrtaceae, is that this extreme form of heterocarpidy has evolved in a family that predominantly has radially symmetric flowers. While the corolla, calyx and stamens are radially symmetric in the heterocarpidic species, the ovary can be either bilaterally symmetric (when there are two indehiscent loculi and two dehiscent loculi) or asymmetric (when there is one indehiscent and two dehiscent loculi). In either case, the axis of symmetry of the ovary does not seem to be strictly aligned either dorsiventrally or at right angles to the stem.

The partly indehiscent capsules (illustrated in Figure 1 and compared in Table 1) found in *Astus* and the *Baeckea robusta* complex are very similar in morphology, although those of the latter group are larger

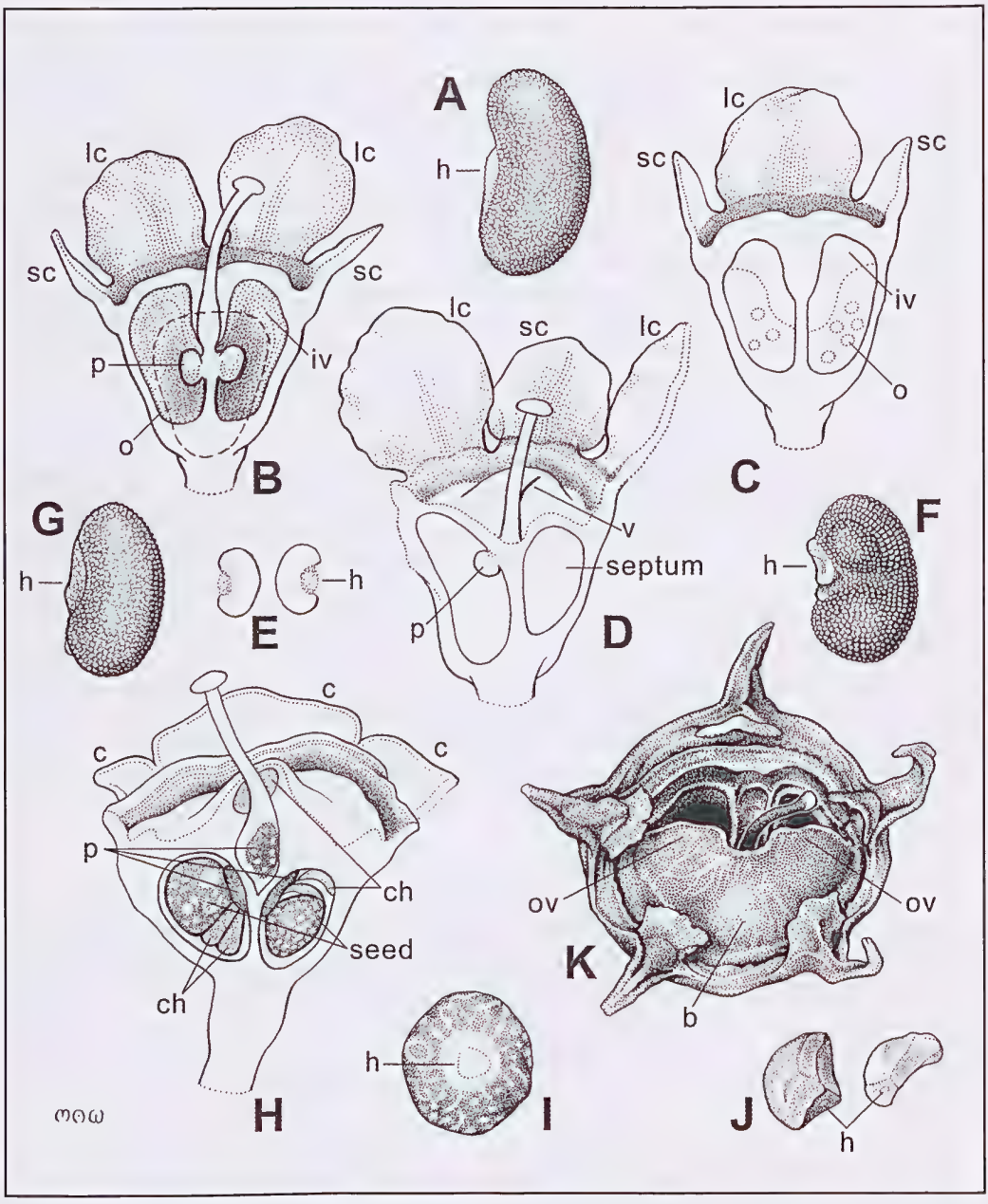

Figure 1. A – *Astus duomilius* seed; B–E. *Astus subroseus*. B,C – two halves of a fruit longitudinally divided along its two valves, the seeds and chaff removed, with the dotted area in B showing the location of the hidden indehiscent loculus; D – fruit divided longitudinally at right angles to the valves, the indehiscent loculus on the left and the septum diving the two dehiscent loculi on the right, E – chaff; F – *Astus tetragonus* seed; G– *Astus wittweri* seed; H–J. *Baeckea* sp. Mingenew. H – longitudinal section of fruit at right angles to the valves, with an additional section through inner end of the valve of a dehiscent loculus, I – seed, J – chaff; K – *Baeckea blackallii* dehisced fruit from top view, with arrow showing the location of the hidden indehiscent loculus. All figures magnified at between ×15 and ×20. Drawn from *G.J. Keighery & N. Gibson* 5005 (A), *M.E. Trudgen* 22079 *& B.L. Rye* (B–E), *R. Meissner* LB164 (F), *E Wittwer* W1898 (G), *G.G. Smith* Dec. 1957 (H–J) and *A.C. Burns* 125 (K).

Key: b – bulge of indehiscent loculus; ch – chaff; h – hilum; p – placenta; o – oil gland; c – calyx lobe, lc – large calyx lobe, sc – small calyx lobe; v – valve, iv – inside of valve, ov – opened valve.

and have more numerous seeds and chaff. In both these plant groups, there are two upper loculi, which show as sutures on the floral disc in the flower. As the fruit matures these loculi become more prominent, with the sutures on ridges, and eventually dehisce. There are also either one or two indehiscent loculi situated somewhat lower in the ovary. The two types of loculi are not superposed, and in fact have a considerable vertical overlap. Transverse sections across the middle of the ovary cut through the lower part of the dehiscent loculi, but through the upper part of the indehiscent loculus or loculi. The dehiscent loculi have a prominent valve that is raised above the level of the remainder of the disc of the fruit, and are broadest along the width of their valve. In contrast, the indehiscent loculi are fully immersed, as they are not or are scarcely raised on the disc, lack a suture, and differ in shape to fit the available space within the fruit. For example in *Astus subroseus* Trudgen & Rye, the single indehiscent loculus has a broad flat summit when viewed from the centre of the fruit (Figure 1B) but is compressed dorsiventrally (with respect to the floral axis) with the base broadest and tapering to the summit when sectioned longitudinally (Figure 1D).

Where there is only one indehiscent loculus, as in *Astus* and also commonly in the *Baeckea robusta* complex, the fruit develops a somewhat lop-sided appearance, especially from the top. In this situation, the two dehiscent loculi have their sutures aligned on a ridge across the disc and the indehiscent loculus sometimes bulges slightly on one side of this ridge (Figure 1K). The indehiscent loculus does not have a suture and has fewer ovules than the dehiscent loculi. However, in one member of the *B. robusta* complex, *Baeckea* sp. Mingenew (*M.E. Trudgen* 12029), there are often two indehiscent loculi, as illustrated in Figure 1H, resulting in a bilaterally symmetric fruit. Three placentas are visible in that figure, two of them for the indehiscent loculi being in side view and positioned slightly lower than the other placenta, which is for one of the dehiscent loculi and is visible from the front. A fourth placenta, for the other dehiscent loculus, is hidden from view. The placenta that is visible from the front view shows the attachment points for eight seeds and chaff.

Seeds developed in the partly indehiscent capsule

Within the Chamelaucieae, many, but not all, of the taxa that have indehiscent fruits have seeds with a very soft testa, while those genera with dehiscent fruits invariably have seeds with a crustaceous testa. Given this, it might be expected that the seeds developing in the indehiscent and dehiscent loculi in *Astus* and the *Baeckea robusta* complex would differ in morphology; however this is not the case.

Many indehiscent-fruited taxa in the Chamelaucieae have only one seed develop even though most of them have more than one ovule in the loculus. Reduced seed number is also found in the indehiscent loculi of the fruit in the two species groups discussed in this paper (see Table 1). In both groups there is usually only one seed in an indehiscent loculus, while in dehiscent loculi the number of seeds produced is more variable, ranging up to four.

Systematic and geographic occurrence of the partly indehiscent capsule

At least eight species of the Myrtaceae have a partly indehiscent capsule. Four of these species belong to the new genus *Astus*, which is described in an accompanying paper (Trudgen & Rye 2005). *Astus* is distributed along the south coast of Western Australia and extends inland to the central wheatbelt and goldfields. The members of the other species group, the *Baeckea robusta* complex, are distributed along the west coast of Western Australia between Kalbarri and Perth. Their generic

placement has yet to be fully determined, but the complex certainly does not belong to *Baeckea s. str.*, a well-defined genus occurring in eastern Australia and extending north to southern China. The *Baeckea robusta* complex is closer to *Babingtonia* Lindl. and *Scholtzia* Schauer than to *Baeckea s. str.*

Table 1. Comparison of the fruits and seeds of *Astus* and the *Baeckea robusta* complex.

Character	*Astus*	*Baeckea robusta* complex
Fruit		
length (mm)	1.7–2.5	2.5–3
width (mm)	1.4–2.2	2.5–3.5
Dehiscent loculi		
position	high	high
number per ovary	2	2
ovule number	2–7	6–14
usual seed number	0–3	1–4
Indehiscent loculi		
position	low	low
number per ovary	1	1 or 2
ovule number	1–4	3–8
usual seed number	1	1
Seed		
shape	broadly reniform	somewhat facetted
length (mm)	1–1.6	1.2–1.4
surface	shallowly colliculate	smooth
Chaff		
shape	broadly reniform	strongly facetted
degree of compression	marked	slight to moderate
texture	soft	hard
colour	often 2-toned, partly translucent	uniformly brown, opaque

Notes: The width of the fruit does not include the width of the limb (i.e. the free part of the hypanthium). The sample size for seed set in *Astus* species was small owing to the small number of fruiting collections available. The position of the loculus is described as *high* when its top has a raised suture from the centre of the flower and the bottom is above the lowest part of the ovary. It is described as *low* when its top only partly touches the disc (and does not have a suture) and the bottom is at the lowest part of the ovary.

Rye (1987) noted that northern populations of *Baeckea robusta s. lat.* had more numerous stamens than the remainder, and it is now clear that these are part of a complex of species. True *Baeckea robusta* (illustrated in Blackall & Grieve 1980: 82) is known from Kalbarri National Park and adjacent pastoral stations south to near Binnu, and has prominently horned calyx lobes, 15–18 stamens mostly concentrated close to the petal claws, and rather broad filaments. The southern taxon, known informally as *Baeckea* sp. Mingenew (*M.E. Trudgen* 12029), is illustrated in Rye (1987: Figure 142). This taxon is very variable and may need to be divided into several species or infra-specific taxa. It extends from near Northampton to Perth and has ridged, but not horned, calyx lobes, 9–14 stamens with 1–4 opposite each calyx lobe, and narrower filaments.

A third member of the *Baeckea robusta* complex is currently known as *B. blackallii* Trudgen ms. This species occurs on sandplain, extending from Tamala Station south-east to Indarra Springs Nature Reserve. Trudgen noted, on a determinavit dated 14 Aug. 1990, that a fruit on the specimen *A.C. Burns* 125 had two dehiscent loculi and one indehiscent loculus. All fruits of this species examined in the current study were of this kind. *Baeckea blackallii* is readily distinguished from *B. robusta* and *B.* sp. Mingenew by its non-rugose hypanthium, which is dotted with obvious oil glands and irregularly longitudinally ridged. Its horned calyx lobes also have a distinct petaline rim, and it has more numerous stamens, with 19–23 per flower. It has up to 14 ovules in each of the dehiscent loculi of its ovary, compared with a maximum of 11 ovules in *B. robusta* and *B.* sp. Mingenew, although it has just as few as or fewer ovules than the other two taxa in its indehiscent loculus.

No other species are known to exclusively produce the partly indehiscent capsule and no other species appear to belong to the *Baeckea robusta* complex; certainly none has been found to have the same seed type with its smooth mottled testa. However, there is one other species that appears to belong in the same genus that produces partly indehiscent capsules in greater frequency than fully dehiscent fruits. This species, *Baeckea* sp. Billeranga Hills (*M.E. Trudgen* 2706), produces both types of fruits on the same branches.

Convergent development of the partly indehiscent capsule in *Astus* and *Baeckea*

Astus and the *Baeckea robusta* complex have evidently developed the same partly indehiscent type of fruit quite independently, as they are not closely related. The degree of separation of these two species groups is indicated by significant differences in their stamens and seeds. *Astus* belongs to the reniform-seeded group with dorsifixed, versatile anthers and a free connective gland (Trudgen & Rye 2005); such stamens are considered the more primitive type in the family. In the *Baeckea robusta* complex the seeds are not reniform and are somewhat facetted, and the highly modified stamens place the complex in what Niedenzu (1893) treated as *Baeckea* subg. *Hysterobaeckea* Nied. The stamens in this part of the Chamelaucieae have the anthers broadly dorsifixed and not versatile and the connective gland fused to the filament and/or anther cells.

The differences between *Astus* and the *Baeckea robusta* complex in their seed types are listed in Table 1 and illustrated in Figure 1. They are perhaps most obvious in the chaff pieces, which are compressed-reniform in *Astus* and strongly facetted in the *Baeckea robusta* complex. The seeds of both groups are more rounded than the chaff pieces so that the basic type, whether reniform or facetted, is not as readily appreciated as in some other species. The seeds of *Astus* are uniformly coloured, minutely colliculate and not very shiny, whereas those of the *Baeckea robusta* complex are mottled, smooth and very shiny. *Baeckea* sp. Billeranga Hills has seeds similar to those of *Astus* in being uniformly coloured and minutely colliculate, but differing in their distinctly facetted shape.

Adaptive significance of the partly indehiscent capsule

The partly indehiscent capsule of *Astus* and the *Baeckea robusta* species complex combines the advantages of the capsule of genera such as *Rinzia* Schauer and *Hypocalymma* (Endl.) Endl., and those of the indehiscent fruit of genera such as *Micromyrtus* Benth. and *Scholtzia*. Having two diaspore types produced from one heterocarpidic fruit presumably:

- increases the protection of the seed retained in the indehiscent loculus from predation of various types,
- increases the variation in response to germination events, and
- increases the variation in dispersal mechanisms.

It seems likely that seeds distributed within the fruit would be less vulnerable to predation than the seeds shed directly into the environment, through a combination of disguise, physical protection and chemical protection. Being enclosed in a non-edible fruit would disguise the seed, making it less obvious as a food source. If the capsule were recognised as being a food source, the inedible casing would still have to be penetrated before the seed could be consumed. This could prevent some organisms, such as small ants, from utilising the seed. Finally, the essential oils in the oil glands of the hypanthium and disc might have a significant effect in inhibiting insect predation and reducing attack by bacteria and fungi.

Enclosure of the seeds probably results in a significant delay in the onset of germination and more variation in when it occurs, so that germination occurs over a longer time period. This effect has been documented in a number of genera of Myrtaceae by Rye & James (1992). Enclosed seeds are apparently not able to imbibe water until the fruit casing has been worn down or broached by exposure to prolonged or more intense rainfall, or by other environmental factors. For example, germination rates in *Thryptomene calycina* (Lindl.) Stapf were found (Beardsell *et al.* 1993) to be very high for seeds enclosed in indehiscent fruits that had been naturally weathered for two years. In contrast, seed germination failed completely for freshly harvested fruits. This phenomenon greatly reduces the risk of simultaneous failure of all or a large proportion of the seeds in one germination event.

The two types of diaspores produced by the partly indehiscent capsule have marked differences in their size, shape and density that would be likely to affect their dispersal. The larger size, more irregular shape and lower density of the diaspore with the enclosed seed probably increase its chances of being transported away from the parent plant. There is also, possibly, an interaction between the delayed germination of enclosed seeds and dispersal. Seeds dispersed within in the fruit would have a much longer time to be moved by a sequence of events, such as heavy rainfall or strong winds, before they germinate.

Collectively, these factors amount to a potentially very significant increase in the chance of seed survival and dispersal through having two kinds of diaspores, and could be expected to lead to increased recruitment over a wider area. The partly indehiscent capsule, seemingly an oddity due to its rarity, therefore appears to confer significant adaptive advantages over a fully dehiscent capsule. These advantages closely parallel the advantages of heterocarpy (having two or more fruit types develop from separate flowers on the same plant).

These apparent advantages do raise the question as to why the partly indehiscent capsule is much less common than either the fully dehiscent or the fully indehiscent multilocular fruit types in the Myrtaceae. The most plausible explanation for its not having arisen frequently is the complexity of this

fruit type, which requires substantial changes from the fully dehiscent capsule, including the loculi not being so integrated in the fruit. Such changes may be much less likely than having all the loculi become indehiscent as in *Scholtzia* and *Enekbatus*. If the main advantage is the better protection of seeds, the latter fruit type may simply be an easier way to get most of the advantage to be gained.

Acknowledgements

The preparation of this paper was made possible by financial support from the Australian Biological Resources Study. We are grateful to Margaret Wilson for the preparation of the line illustration.

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Astus, a new Western Australian genus of Myrtaceae with heterocarpidic fruits

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Abstract

Trudgen, M.E. and Rye, B.L. *Astus*, a new Western Australian genus of Myrtaceae with heterocarpidic fruits. *Nuytsia* 15(3): 495–512 (2005). *Astus* Trudgen & Rye, a new genus of Myrtaceae with four species endemic to the south-west of Western Australia, is described and its affinities discussed. While the genus is circumscribed on the basis of a range of characteristics that separate it from related genera, all its members are unusual in having a fruit with both dehiscent and indehiscent loculi. In addition, two of the species have a marked heteromorphy in their calyx lobes. *Astus* is one of a number of genera belonging to the tribe Chamelaucieae that have reniform seeds. While the floral morphology of the new genus does not readily indicate which of the other reniform-seeded genera it is closest to, DNA evidence indicates affinities to the Eastern Australian genus *Triplarina* Raf. The type species, *Astus tetragonus* (F. Muell. ex Benth.) Trudgen & Rye, is based on *Baeckea tetragona* F. Muell. ex Benth. *Astus duomilius* Trudgen & Rye, *A. subroseus* Trudgen & Rye and *A. wittweri* Trudgen & Rye are new species. A key to the species, descriptions, illustrations and distribution maps are provided.

Introduction

Four species of Myrtaceae endemic to the south-west of Western Australia are described as a new genus, *Astus*, on the basis of a suite of characteristics that separates them from all other members of the family. The position of *Astus* in the recently redefined tribe Chamelaucieae (Wilson *et al.* 2005), the degree of variation within the genus and its distinction from other genera are discussed.

Most aspects of the morphology of the new genus are well within the range of morphological variation known within the Myrtaceae. This includes characteristics such as leaf size and shape, inflorescence type, stamen number and arrangement, anther type, placentation and ovule number. However, *Astus* is very unusual in that all four species have two distinct types of carpels in the same ovary. These develop into dehiscent and indehiscent loculi in the fruit, with two quite different modes of seed dispersal. This heterocarpidic fruit type does not appear to have been reported previously for the Myrtaceae, but is also known in the *Baeckea robusta* F. Muell. species complex. It is described, illustrated, and discussed in more detail in an accompanying paper (Rye & Trudgen 2005). Not only is this fruit type a very unusual phenomenon for the Myrtaceae, it is apparently extremely rare among the angiosperms as a whole.

Two of the four species placed in *Astus* also have obviously heteromorphic calyx lobes. While some degree of calyx heteromorphism is not unusual in the Chamelaucieae, the degree of calyx heteromorphism present in *Astus* is exceptional.

Taxonomic history and position of *Astus* within the Myrtaceae

The only member of *Astus* described prior to this revision was the type species, *Astus tetragonus*, which was named as *Baeckea tetragona* by Bentham (1867) in his treatment of the Myrtaceae for "Flora Australiensis". In that treatment, *Baeckea s. lat.* was included within the tribe Leptospermeae because it had a dry multi-locular fruit, and the distinguishing characteristics noted for its subtribe Baeckeinae [as Baeckeaeae] were the minute cotyledons on the embryo, the opposite leaves and the stamens being shorter than the petals.

Bentham placed *B. tetragona* in *Baeckea* section *Euryomyrtus* (Schauer) Benth., which has since been reinstated as a genus. He noted that the seeds were similar to those of *Baeckea diffusa* Sieber ex DC. (a synonym of *Euryomyrtus ramosissima* (A. Cunn.) Trudgen). Niedenzu (1893) appears to have followed Bentham's sectional concepts, so presumably also included *Baeckea tetragona* among the six species he recognised for section *Euryomyrtus*, although it was not one of the two species he cited as examples of the group.

In their informal classification of the Myrtaceae, Briggs & Johnson (1979) placed the genera of subtribe Baeckeinae in their *Baeckea* suballiance of the *Chamelaucium* alliance. However, in a later paper these authors concluded that their two suballiances for the *Chamelaucium* alliance were unnatural and so abandoned them (Johnson & Briggs 1985). Recent studies based on DNA sequencing have provided evidence that the *Chamelaucium* alliance is a monophyletic group, with the most recent publication resulting from this work (Wilson *et al.* 2005) formally recognising the alliance as a new broad circumscription of tribe Chamelaucieae.

Within the subtribe Baeckeinae, as it was previously recognised, Trudgen (1986, 1987, 2001) distinguished a group of genera that were characterised by having crustaceous reniform seeds, a dehiscent multi-locular fruit and the most common anther type in the Myrtaceae – one with an external connective gland and dehiscence by two parallel slits. He included *Baeckea tetragona* and its allies within this reniform-seeded group, which he regarded as a natural group. The taxa Trudgen (in prep.) now includes in this group are *Astus*, *Cyathostemon* Turcz. (which we intend to reinstate in a subsequent paper), *Enekbatus* Trudgen & Rye ms., *Euryomyrtus* Schauer, *Hypocalymma* (Endl.) Endl., *Ochrosperma* Trudgen, *Rinzia* Schauer, *Triplarina* Raf., and some as yet unplaced species such as *Baeckea crassifolia* Lindl., *Baeckea ericaea* (F. Muell.) Benth. and *Baeckea polystemonea* F. Muell.

The reniform seed, which generally has a relatively large size, non-facetted shape, thick testa, colliculate to tuberculate patterning, and sometimes has an aril, is a key character which appears to be an indication of a monophyletic group, although further studies may extend the boundaries of that group. Given the apparently strong morphological evidence for the reniform-seeded group as a natural entity, it is interesting that it was not clearly defined in two molecular analyses (Lam *et al.* 2002, Wilson *et al.* 2004) of the Chamelaucieae, and that *Astus* was indicated as definitely not belonging within the reniform-seeded group. While several subgroups were supported to some degree in these analyses, based on sequencing of up to four chloroplast regions, the reniform-seeded group as a whole was not, although a significant portion of the overall analysis was largely unresolved.

The relatively small number of species sampled for each genus may partly explain this. Alternatively, the chloroplast regions examined may have either insufficient or too much variation in their sequences to be useful in this portion of the analysis. The current extension of molecular sampling to more species in the Chamelaucieae is at least partly addressing the issue of sample size. Recent sampling of a nuclear DNA region is also resolving some of the problems with the published analyses and now shows *Astus subroseus* coming out closely with two species of *Triplarina* (Peter Wilson pers. comm.).

Calyx lobe heteromorphy in *Astus subroseus* and *A. tetragonus*

Bentham (1867: 77) noted that the two outer calyx lobes (i.e. those that enclose the others and petals in the buds) in "*Baeckea tetragona*" could be "narrower and greener" than the inner ones. However, he did not give any indication of the magnitude of this difference. In fact, the difference is quite marked, with the outer two calyx lobes having a herbaceous centre and being noticeably shorter than the petals, while the others are petaline and almost as long as the petals but narrower. A slightly more pronounced heteromorphy occurs in *Astus subroseus* with a greater difference in size between the outer and inner calyx lobes (Figure 2D,I). In contrast, *Astus duomilius* and *A. wittweri* have uniformly sized calyx lobes, all far smaller than the petals and all with a herbaceous centre and scarious edges.

It is fairly common for the outer two calyx lobes to be more herbaceous than the inner ones in the Chamelaucieae, as the outermost ones have a protective function in the buds. It is also common for the inner calyx lobes to be somewhat broader than the outer ones and to have larger numbers of stamens opposite them, as occurs in two of the *Astus* species. However, such a marked heteromorphism in the calyx lobes as found in these *Astus* species has not been observed in any other members of the tribe.

The three petaline calyx lobes found in *Astus subroseus* and *A. tetragonus* fill small gaps between the petals, as can be seen from the photograph of the flower of the latter species (Figure 1B). Although this does not alter the diameter of the flowers, it may increase their surface area sufficiently to increase the frequency of visits by pollinating insects. The development of petaline calyx lobes, but of a more uniform size, is also present in a number of other groups of species in the Myrtaceae, even to the extent of the calyx lobes becoming larger than the petals in species such as *Thryptomene calycina* (Lindl.) Stapf. Rather than indicating a close relationship, this appears to be another occurrence of convergent evolution in relatively distant groups within the Chamelaucieae.

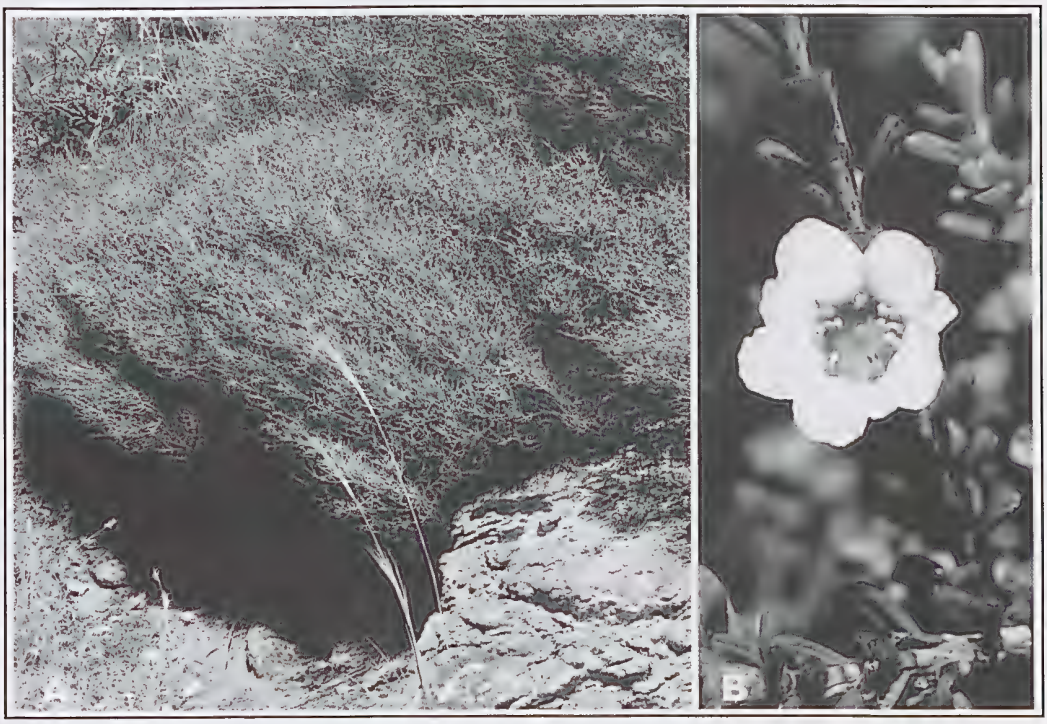

Figure 1. Photographs of *Astus tetragonus* taken at Cape Le Grand by P.J. Rye. A – habit; B – flower.

Distinction of *Astus*

The distinction of *Astus* as a separate genus is based on all four species having a combination of morphological characters that is unique both within the Chamelaucieae and within the Myrtaceae as a whole. Other genera may have some of the characters listed below, but they do not have the entire suite of them. The combination of characters found in *Astus* that distinguishes the new genus from all other genera of Myrtaceae is:

- hypanthium obconic in the flower, slightly longer than broad or up to about 1.3 times longer;
- hypanthium five-angled, without a true rib on the angle, although (particularly in dried material) it may appear ribbed;
- inflorescence a single, shortly pedunculate flower;
- stamens of the (presumed primitive) taxonomically widespread type with a more or less terete filament, free connective gland, and the anthers dorsifixed, versatile and with parallel loculi opening in longitudinal slits;
- ovary multi-locular, fused for all of its length to the hypanthium; disc deeply concave, except for a small convex area at the centre (around the style base);
- ovary walls thin at the flowering stage, only thickening slightly in the fruit;
- ovary loculi of two types: the type that becomes dehiscent in fruit having a broad summit where the valve forms, the other type (indehiscent in fruit) being broader towards its base and positioned somewhat lower in the ovary;
- fruit a derivative of a capsule, usually with two dehiscent and one indehiscent loculi, fused for its length to the hypanthium and enclosed by it except at the top, the ovary expanding upwards;
- the hypanthium remaining obconic and five-angled in the fruit (although there may be bulges around individual loculi);
- dehiscent loculi not opening very widely, with the valves not much thickened;
- seeds reniform, with a crustaceous testa, colliculate, moderately large, with no aril.

Astus is easily distinguished from the other reniform-seeded members of the Chamelaucieae by a combination of characters relating to the hypanthium. In *Astus*, the hypanthium is obconic, five-angled, thin (especially in the fruit) and somewhat longer than broad. In the flowering stage the whole length of the ovary is fused to the hypanthium, so that only the top of the ovary is free, although in the fruiting stage, some expansion of the loculi at their summit (the top of the valves) occurs, resulting in a greater proportion of the fruit being free from the hypanthium.

Also important in distinguishing *Astus* are seed characters, such as the lack of an aril, and fruit characters. The valves of the fruit are not very thick and do not open particularly widely, in contrast to genera such as *Rinzia* and *Euryomyrtus*, where the fruit has thicker valves and opens very widely.

While the partially indehiscent fruit of *Astus* species undoubtedly adds significantly to the distinction of the genus, the four species referred to *Astus* would still be substantially different from related genera and still deserve generic status if they had only dehiscent loculi. The intriguing fruit type of *Astus* probably evolved after the genus separated from other genera.

Comparisons of *Astus* to related genera

In the reniform-seeded group there is wide variation between the genera in stamen arrangement, the degree of fusion of the ovary to the hypanthium and other characters. The distinction of *Astus* as a genus, and its separation from other genera, is therefore perhaps best appreciated by individual comparisons between it and the other genera placed in the group. This has the additional benefit that when *Astus* is compared individually to another genus (or to a small group of genera), significant additional differences are identified that add to the understanding of the differentiation of the new genus.

The stamens of *Astus* are of the widespread type with versatile, dorsifixed anthers and terete filaments with the connective gland free from the filament. These stamens distinguish *Astus* from *Rinzia*, *Hypocalymma* and *Cyathostemon*. *Rinzia* has the anthers fixed to the front of the filaments, i.e. the anthers are dorsifixed, but not versatile, while *Hypocalymma* and *Cyathostemon* have basifixed anthers. While *Astus* and *Hypocalymma* have terete filaments, *Rinzia* and *Cyathostemon* have flattened filaments, but in *Astus* the filaments are free while in the other three genera they are fused (either shortly, or for much of their length). Adding to the separation of *Rinzia*, *Hypocalymma* and *Cyathostemon* from *Astus*, all three have a more or less cup-shaped hypanthium with the capsule free for more of its length and opening more widely. These three genera are quite distinct from *Astus*.

Astus has similar stamens to those of *Euryomyrtus*, and Bentham (1867) evidently considered these two plant groups to be closely related. *Euryomyrtus* differs from *Astus* in its arillate seeds, more rounded hypanthium, broader more widely opening fruit and its rather prominent groups of processes (small finger-like projections) opposite the petals. Processes are also present in *Astus* but are minute and are not united into groups.

The differentiation of *Astus* from *Ochrosperma* is also quite clear. While these two genera have similar stamens and both have the ovary fully or almost fully fused to the hypanthium, the hypanthium is significantly broader than long and not angled in *Ochrosperma* but more elongate (as long, or slightly longer than broad) and five-angled in *Astus*. In *Ochrosperma* the fruit opens fairly widely to widely, the seeds are arillate, and there are 5–8 stamens, with usually one opposite each calyx lobe, but two opposite some calyx lobes in *O. adpressum* A.R. Bean (Bean 1995). In contrast, in *Astus* the fruit does not open widely, the seeds are not arillate, and there are 8–12 stamens, with either 1–3 opposite each calyx lobe or one opposite each petal and calyx lobe.

As *Astus* and *Triplarina* both have the ovary fully fused to the hypanthium and both have seeds without an aril, the differences between them seem somewhat less. However, while *Astus* has 8–12 stamens, either one opposite each petal and calyx lobe or 1–3 opposite each calyx lobe, *Triplarina* has 14–19 stamens, with several opposite each calyx lobe. *Astus* also has larger seeds. The fruit of *Triplarina* is somewhat intermediate between that of *Astus* and that of other genera such as *Rinzia*, but more similar to the latter in its more pronounced development of the valves and greater enlargement upwards after flowering, the hypanthium flattening somewhat in the opened fruit, and the valves opening moderately widely.

A number of species in the reniform-seeded group do not fit in any of the named genera, including *Baeckea crassifolia*, *Baeckea ericaea*, *Baeckea polystemonea* and at least five currently undescribed species. All of these species can be readily separated from *Astus* by their more rounded and broader hypanthium and widely opening fruits that are largely free of the hypanthium. Additionally, these species differ from *Astus* either in having flattened filaments or in their stamen arrangements, and two of them have glandular staminodia as well as normal stamens.

Although *Astus* appears to have significant morphological similarities to each of the other reniform-seeded genera, it is by no means clear which of these genera show the greatest affinities to *Astus*. The molecular data of Lam *et al.* (2002) placed *Astus* closest to a pair of species (*Baeckea corynophylla* F. Muell. and *Baeckea uncinella* Benth.) with a very different morphology, including a quite different type of anther and facetted seeds. However, the recent sampling of the ETS nuclear DNA region now shows *Astus subroseus* coming out within one of the reniform-seeded clades, in close association with two species of *Triplarina* (Peter Wilson pers. comm.).

Given the clear differentiation of the new genus from each of the other genera of the Chamelaucieae with reniform seeds, and the unusual fruit type that the members of *Astus* have, we conclude that *Astus* is a distinctive new genus easily deserving generic status. While the closeness of the relationship of the new genus to other genera in the reniform seed group is not immediately clear, the similarity of the fusion of the ovary to the hypanthium in *Astus* and *Triplarina* and the indication from DNA studies that these genera may be close is an intriguing possibility given the disjunction between them.

Heterogeneity in *Astus*

The four members of this genus fall into two distinct pairs of species, which are compared in Table 1. The first pair, referred to here as the typical pair, consists of the type species *Astus subroseus* and *A. tetragonus*. These two species are very similar in morphology and clearly very closely related to one another. The other two species, *A. duomilius* and *A. wittweri* are also closely related to each another but not to the same degree as the members of the typical pair. They differ from the typical pair in having caducous rather than persistent bracteoles, a regular arrangement of the stamens opposite the calyx lobes and petals, floral processes opposite the petals rather than the calyx lobes, and uniformly small non-petaline calyx lobes rather than heteromorphic calyx lobes.

While these differences suggest that the two pairs of species have been separated for some considerable time, we do not consider them to justify the recognition of two separate genera. The characters that unite *Astus* and differentiate it from the other genera in the reniform-seeded group, especially the relatively narrow, five-angled hypanthium and the heteromorphic carpels, appear to us to be more important. Consequently, *Astus* is accepted here as a genus of significant antiquity, and which has a range of morphology reflecting that antiquity. In a larger genus, the differences listed would justify erecting subgenera or sections.

Seed development and insect associations

The properly developed seeds found in indehiscent loculi of *Astus* species have the same morphology as those developed in dehiscent loculi. Such seeds are similar to the reniform seed type found in genera such as *Rinzia*, *Euryomyrtus* and *Hypocalymma*. Seeds of three *Astus* species are illustrated in the accompanying paper (Rye & Trudgen 2005).

However, as well as normal seeds, galled seeds are developed in at least two *Astus* species as the result of parasitism of ovules by a minute insect larva. Such "seeds" develop a shape and testa morphology quite unlike that of normal seed. Rather than developing the normal reniform shape, galled seeds are more irregular and commonly subglobular. A galled seed is illustrated (Figure 2F) for *A. subroseus*; this is deeply colliculate around the hilum and more reticulate elsewhere. Showing the

Table 1. Morphological differences between the two pairs of species in *Astus*.

Character	*A. duomilius* and *A. wittweri*	*A. subroseus* and *A. tetragonus*
bracteoles	caducous	persistent
bud apex		
lobes	not very prominent	prominent
centre	highly raised	concave to flat
calyx lobes		
hetermorphism	absent	present
texture	mostly herbaceous	mostly petaline
stamen number		
opposite each calyx lobe	1	1–3
opposite each petal	1	0
processes	opposite petals	opposite calyx lobes

variability in galled seeds, one illustrated (Figure 2K) for *A. tetragonus* is reticulate. The larvae apparently remain within one ovule, as normal and galled seeds have been observed to develop within the same fruit.

Development of galled seeds has been observed in *Astus subroseus* and *A. tetragonus*. While no galled seeds have been observed in *A. duomilius* and *A. wittweri*, this may be due to the fact that relatively little material of these two species has been available for study.

Distribution and habitat range

Astus is restricted to an area of the South West Botanical Province and South-western Interzone of Western Australia as defined by Beard (1980). It occurs along the coast from just east of Albany to Point Culver on the Great Australian Bight and inland to Wyalkatchem and east to near Coolgardie. The distributions of the four species, presented in Figure 3, are plotted on maps marked with the interim biogeographic (IBRA) regions of Thackway & Creswell (1995) which correspond fairly closely to Beard's (1980) botanical districts. The distribution of *Astus* as a whole is quite similar to that of the much larger genus *Cyathostemon*, but does not extend as far to the north-west.

Three *Astus* species are found on or near the south coast, predominantly in the Esperance biogeographic region. *Astus tetragonus* occurs through much of this region, associated mostly with granitic rocks, but is absent from the far western and far eastern parts of this region. *A. duomilius* occurs within the range of *Astus tetragonus*, but prefers a quite different habitat, being known from only one locality on a sand dune next to a saline lake. *Astus wittweri* occurs east of *Astus tetragonus*; and is known only from Mt Ragged, where it is associated with gneissic (granitic) rocks, and Point Culver.

In contrast to these three species, *Astus subroseus* has a more inland distribution, occurring over a quite large area in the Avon, Mallee and Coolgardie biogeographic regions. It is well separated from the other taxa except where it approaches the range of *A. tetragonus* near Ravensthorpe. In that region, *A. tetragonus* occurs associated with some granitic outcrops east and south of Ravensthorpe while *A. subroseus* has been recorded from lateritic soil north of Ravensthorpe.

It can be seen from the ranges described above that the three *Astus* species that are often or sometimes associated with rocky habitats have more or less parapatric ranges. They show a pattern of geographic 'replacement', that is the species occupy similar habitat (at least for the geological component of habitat) with *Astus tetragonus* occurring immediately to the south of where the range of *A. subroseus* ends and immediately to the west of the known range of *A. wittweri*.

An intriguing aspect of the habitat preferences of the new genus is that there are some similarities to the habitat preference of the eastern Australian genus *Triplarina*, which also tends to occur in sheltered or relatively damp sites such as near the bases of granite outcrops (Bean 1995).

Description of the new genus

Astus Trudgen & Rye, *gen. nov.*

Frutices glabri. Folia opposita, decussata, parvula. Flores solitarii in axillis foliorum positi, bracteolis paribus oppositis ad juncturam pedunculi cum anthopodio. Hypanthium costis 5 sepalis oppositis. Sepala 5, in fructu persistentia. Petala 5, ungue basali brevi. Androecium ex staminibus 8–12 in unum verticillum dispositis; stamina aequidistantia sepala et petala opposita vel inordinata 1–3 in quoque sepalo opposita et processibus filiformibus parvis sepalis vel petalis oppositis; filamenta filiformia; antherae dorsifixae, versatiles, cellulis parallelibus longitudinaliter dehiscentibus, connectivo in glande plus minusve globulari terminanti. Ovarium 2–4-loculare, cellulis (1)2–7-ovulatis; placentae axiales, peltatae. Styli basis in depressione inserta. Fructus siccus, plerumque loculis valvatis 2 et loculo non-valvato unico, pariete satis tenui, coriaceo-crustaceo. Semina reniformia; arillus carens.

Typus: *Astus tetragonus* (F. Muell. ex Benth.) Trudgen & Rye

Shrubs small or medium-sized, glabrous. *Leaves* opposite, decussate, appressed to widely spreading, entire, petiolate; lamina very small, very narrowly obovate to obovate or rarely elliptic in outline, somewhat to very thick, with prominent oil glands, abaxial surface convex to very deeply convex, adaxial surface shallowly concave to shallowly convex. *Flowers* in 1–8(15) decussate pairs clustered at tips of branchlets, solitary in leaf axils, fairly erect, with two opposite bracteoles located at the junction of the peduncle and the anthopodium. *Bracteoles* subulate to broadly ovate, with a herbaceous keel and scarious margins, somewhat folded inwards, acute. *Hypanthium* obconic or broadly obconic, (4)5-

angled, the angles opposite the centres of the calyx lobes and sometimes appearing to be somewhat ribbed, especially when dried. *Calyx* lobes (4)5, all or the outer ones with an incurved herbaceous keel, persistent in fruit. *Petals* (4)5, widely spreading, scarcely clawed, more or less circular, white to medium pink or purplish pink, deciduous in fruit. *Stamens* 8–12, usually 10, inserted singly (not in bundles), either equidistant and one opposite each petal and each calyx lobe, or irregularly arranged with 1–3 opposite each calyx lobe; processes opposite either the calyx lobes or the petals, filiform, small. *Filaments* curved inwards, reaching about the same level as the stigma, often with the base broad and flattened, almost terete above, tapering towards apex. *Anthers* dorsifixed, slightly longer than wide; thecae parallel, opening in full-length slits; connective gland prominent, globular or broadly obovoid. *Ovary* adnate to hypanthium, usually 3-locular but appearing 2-locular from above, with one of the loculi somewhat more basal than the others, the lower loculus differently shaped and sometimes reduced in size; placentas axile, peltate, elliptic to circular, not obviously stalked; ovules up to 7 per loculus, either inserted in a horseshoe shape or in 2 rows, but variable in number with occasional loculi sometimes having as few as 1 ovule or none, more or less reniform, often 2-toned. *Style* fairly stout, slightly tapering towards stigma, base inserted in a narrow cavity; stigma peltate or capitate, more or less circular from top view. *Fruit* multi-locular, dry, usually with 2 valvate loculi and 1 non-valvate loculus, fairly thin-walled, leathery-crustaceous, summit hidden (from side view) within the free portion of hypanthium, apparently with a maximum of one seed produced in each loculus or a maximum of 1 seed per fruit; hypanthium more or less hemispheric to almost obconic; valvate loculi usually 2, broadest across the width of the terminal valve; non-valvate loculus entirely below the level of the valves of the dehiscent loculi but considerably overlapping with them. *Seeds* reniform, 1–1.6 mm long; testa minutely colliculate (with numerous convex cells), pale to medium brown, somewhat shiny; hilum very small, situated on a ridge-like area across the inner part of the seed; aril absent. *Chaff pieces* soft or somewhat crustaceous.

Size and distribution. A genus of four species restricted to the South West Botanical Province and South-western Interzone of Western Australia. Figure 3 shows the distribution of members of the genus.

Etymology. From the Latin *astus* – craft or cunning, referring to the strategy of having two kinds of diaspores and so presumably enhancing the chances of successful recruitment.

Key to species

1. Leaves not or scarcely keeled. Bracteoles caducous. Calyx lobes all very reduced. Stamens equidistant, opposite the calyx lobes and petals
  2. Leaves 0.6–0.7 mm wide, about as wide as thick. Anthopodium 0.5–0.7 mm long. Flowers *c.* 6 mm diam. (Mt Burdett area) ..... **A. duomilius**
  2. Leaves 1.2–1.6 mm wide, much wider than thick. Anthopodium 1.5–2 mm long. Flowers 7.5–9 mm diam. (Mt Ragged to Point Culver) ..... **A. wittweri**
1. Leaves with an obvious keel especially towards apex. Bracteoles persistent. Calyx lobes varied in size, the largest ones petal-like. Stamens irregularly spaced, with 1–3 opposite each calyx lobe
  3. Young leaves with 2 or 3 rows of prominent oil glands on each side of midvein. Corolla white or very pale pink. (Cape Riche to Cape Arid National Park) ..... **A. tetragonus**
  3. Young leaves with 1 row of prominent oil glands on each side. Corolla pale to medium pink or purplish pink. (Wyalkatchem to Coolgardie to Ravensthorpe) ..... **A. subroseus**

Astus duomilius Trudgen & Rye, *sp. nov.*

Folia latitudine circa longitudine aequantia. Bracteolae caducae. Sepala plus minusve aequaliter redacta. Stamina 10, sepalis et petalis opposita.

Typus: E of Mt Burdett [precise locality withheld], Western Australia, 14 Oct. 2000, *G.J.Keighery & N. Gibson* 5005 (*holo:* PERTH 06691544; *iso:* MEL).

Illustration. Rye & Trudgen (2005: Figure 1A).

Shrub size not recorded, with short leafy branchlets on long stems, the leaves mostly widely antrorse to patent, crowded on the branchlets, mostly shed on lower stems. *Petioles c.* 0.6 mm long. *Leaf blades* very narrowly obovate in outline, 3–3.5 mm long, 0.6–0.7 mm wide, about as thick as wide, apex obtuse; abaxial surface very deeply convex, with *c.* 7 rows of prominent oil glands with *c.* 6 glands per row; adaxial surface shallowly convex to shallowly concave, with fewer rows of oil glands but the glands similar in size and separation to those on abaxial surface. *Inflorescence* usually of 1 or 2 pairs of flowers clustered at tip of each branchlet. *Peduncles* 0.4–0.5 mm long. *Bracteoles* caducous, not seen. *Anthopodium* 0.5–0.7 mm long. *Buds* 5-lobed around a concave to flat apex. *Flowers* 5-merous, *c.* 6 mm diam. *Hypanthium* obconic or broadly obconic, *c.* 2.8 mm long, *c.* 2.5 mm diam., glandular but scarcely rugose; free portion 0.6–0.8 mm long. *Calyx lobes* 5, all of a similar size, very depressed, 0.5–0.7 mm long, 1.2–1.6 mm wide, strongly incurved at apex, with a very thickened herbaceous base and a scarious margin, the base keeled and reddish. *Petals* 5, widely spreading, scarcely clawed, subcircular, *c.* 2 mm long, white. *Androecium:* stamens 10, one opposite each petal and calyx lobe, the antipetalous ones with a filament *c.* 0.7 mm long, the antisepalous ones tending to be slightly shorter; processes few or absent, opposite the petals, minute. *Anthers c.* 0.35 mm long; connective gland *c.* 0.1 mm diam. *Ovary* 3-locular, the indehiscent loculus reduced in size; ovules in two valvate loculi 2–4 (usually 3), in non-valvate loculus solitary, uniformly coloured or sometimes somewhat 2-toned. *Style c.* 1.5 mm long; stigma peltate, 0.3–0.35 mm diam. *Fruit* usually heart-shaped in outline, *c.* 2.5 x 2 mm, with summit prominently 2-lobed, each lobe corresponding with one of the 2 valvate loculi, but occasionally with one of the valvate loculi aborted and only one valve developed, the non-valvate loculus of a similar volume but more compressed, the remainder of the fruit (at the base and extending slightly up one side) with an open reticulum of spongy tissue; indehiscent loculus to one side of fruit, its summit reaching the base of the lobes; lobes *c.* 0.7 mm high; hypanthium broadly obconic-obovoid, glandular but without obvious ribs. *Seeds* straightened-reniform or slightly obovoid-reniform, 1.4–1.5 mm long, 0.6–0.7 mm wide and thick (slightly thicker than wide), yellowish brown; hilum *c.* 0.3 mm long.

Distribution and habitat. Endemic to Western Australia, recorded from a single locality south of Kau Rock with orange sand on a gentle slope of a lake dune, in a somewhat saline habitat, associated with some species such as *Darwinia drummondii* that are restricted to semi-saline locations but also with species of more general distribution such as *Eucalyptus kessellii*. (Figure 3A)

Flowering period. The single known specimen had mature fruits and was also in late flower in mid October.

Conservation status. Conservation Codes for Western Australian Flora: Priority One. *Astus duomilius* is known only from the type collection on crown land.

Etymology. The specific epithet is taken from the Latin *duo* – two and *milia* – thousand, to commemorate

the year 2000 when the first known collection of the new species was made.

Affinities. Differs from all other *Astus* species in the shape of its leaves and its habitat on a somewhat saline dune. It is closely related to *A. wittweri* but, apart from the major difference in its leaves, can be distinguished by its shorter peduncles and anthopodium, smaller flowers and fewer ovules.

Notes. In the small sample of fruits examined, there was usually a single seed in one of the dehiscent loculi and a single seed in the indehiscent loculus, giving a total seed set of two. One of the fruits appeared from external examination to be uniformly 3-locular, i.e. with three equally positioned dehiscent loculi. When dissected, however, it was found to have two dehiscent loculi less developed than usual because both lacked a mature seed, although one had a partially developed but aborted seed; the indehiscent loculus had a large mature seed protruding from the disc surface to a similar degree to the two under-developed dehiscent loculi.

Astus subroseus Trudgen & Rye, *sp. nov.*

Asto tetragono affinis sed floribus majoribus magis coloratis, foliis plerumque minoribus glandulis oleosis paucioribus differt.

Typus: Roe Location 2621, 32° 57' S, 118° 42' E, Western Australia, 6 Oct. 1997, *J. & M. Stewart* 30B (*holo:* PERTH 05038448; *iso:* CANB, MEL, PERTH).

Illustration. Rye & Trudgen (2005: Figure 1B–E).

Compact rounded *shrub*, 0.3–1.2 m tall, with many erect branchlets. *Leaves* appressed or antrorse, fairly crowded on the branchlets; petiole 0.1–0.5 mm long. *Leaf blades* obovate, 1–2 mm long, 0.8–1.2 mm wide, thickened, apex obtuse, margins often minutely denticulate; abaxial surface with an obvious keel especially towards apex, often produced into a small subterminal point, with large oil glands mostly in 1 or 2 rows on each side of keel, (1 row of oil glands in the youngest leaves on each branchlet but sometimes 2 rows on older leaves); adaxial surface with less prominent oil glands. *Inflorescence* of 1–3 pairs of flowers clustered at the tip of each branchlet. *Peduncles* 0.4–1.2 mm long. *Bracteoles* persistent, ovate to very broadly ovate, acutely keeled and with broad scarious margins, 0.6–1.7 mm long; apex acute to strongly incurved. *Anthopodium* 0.4–1.1 mm long. *Buds* with a highly raised apex. *Flowers* 5-merous but apparently up to 8-merous as a result of the combination of the 3 largest and most petaline calyx lobes with the 5 petals, pale to medium pink or purplish pink, 5–7 mm diam. *Hypanthium* obconic, 1.5–2.5 mm long, 2.0–2.8 mm diam., glandular and often very rugose between the ribs; free portion *c.* 0.6 mm long. *Calyx lobes* 5, slightly spreading to spreading, very unequal in length, 1.3–1.5 mm wide; largest calyx lobe petaline, broadly ovate, 1.5–1.8 mm long; smallest calyx lobe sepaline, depressed ovate, 0.7–1 mm long, with a prominent keel, incurved at apex, the outer surface deep pink (sometimes also with green) with a whitish margin, often slightly auriculate at base. *Petals* 5, more or less circular, 2–2.5 mm long. *Androecium* of 10(12) stamens, with 1–3 opposite each calyx lobe, with a filament 0.8–1.2 mm long; processes few, opposite calyx lobes, 0.05–0.15 mm long. *Anthers* 0.3–0.5 mm long; connective gland 0.1–0.2 mm diam. *Ovary* 3-locular, with two of the loculi broad and protruding at summit but not reaching base of ovary; third loculus not protruding at summit, reaching narrow base of ovary but overlapping the other two loculi for most of its length; ovules 2–5 (usually 3 or 4) per loculus, 2-toned with a dark-coloured strip adjacent to the placenta. *Style* 0.7–1.5 mm long; stigma nearly capitate to distinctly peltate, 0.15–0.2 mm diam. *Fruit* heart-shaped in outline, *c.* 2 x 1.8 mm, the summit 2-lobed, with 2 valvate terminal loculi (one in each lobe) and 1 non-valvate loculus at a lower level, without any spongy tissue, 1-seeded

as far as known; lobes extending *c.* 0.3 mm above the base of the free part of the hypanthium but deeper at centre of fruit; indehiscent loculus to one side of fruit, its summit reaching the base of the lobes; hypanthium very broadly obconic-obovoid, prominently ridged and rugose. *Viable seeds* broadly reniform, not seen fully mature but the largest seen *c.* 1.3 mm long, *c.* 0.8 mm thick, pale brown. *Insect-galled seeds* somewhat irregular in shape and patterning, 0.8–1.2 mm long, 0.4–0.6 mm wide, 0.6–0.7 mm thick, very pale brown; hilum compressed, 0.5–0.6 mm long, brown. (Figure 2A–F)

Selected specimens examined. WESTERN AUSTRALIA: 15 miles [24 km] E of Jurakin, near Bruce Rock, Sep. 1933, *E.T. Bailey* (PERTH); Muntagin, Sep. 1945, *E.T. Bailey* 212 (PERTH); *c.* 40 km S of Merredin on Narembeen road, 21 Aug. 1977, *B. Ballingall* (PERTH); Kalgarin turn off, 10.4 miles [16.7 km] W of Hyden, 9 Sep. 1966, *M. Barrow* M90 (PERTH); Woodline, 60 miles [97 km] S of Coolgardie, 3 Sep. 1926, *J.B. Cleland* (AD); Burngup Water Reserve, 9 Sep. 1996, *A.M. Coates* 4423 (CANB, NSW, PERTH); road to Bank Rock, 9 km W of junction with 'Eyre' Highway [Coolgardie–Norseman road], 14 Sep. 1989, *B.J. Conn* 3131 *& J.A. Scott* (PERTH); Lake Wagin, 1893, *Miss Cronin* (MEL); *s. loc., J. Drummond* (MEL76286); 230 mile peg [370 km] on Menzies road [near Southern Cross], *J. Elliot* (PERTH); 20 miles [32 km] NW of Ravensthorpe, 14 Aug. 1925, *C.A. Gardner* 1769 (PERTH); *c.* 15 km SE of Londonderry Siding, 14 Sep. 1964, *R.H. Kuchel* 1766 (AD, PERTH); 30 km W of Kumarl, 10 Oct. 1966, *P.G. Wilson* 5680 (MEL, PERTH).

Distribution and habitat. Endemic to Western Australia, with most records from Wyalkatchem south-east to just north of Ravensthorpe, and with four records further east from the Coolgardie area to near Kumarl. At some localities *Astus subroseus* occurs on granitic rocks or on the apron of soil adjacent to granitic rock, but habitat details are not given for most collections. It occurs in a variety of soils including, well drained brown sandy loam, fine sand, reddish sand over clay, pale brown loamy sand over orange-brown gritty clay and pale brown sandy loam with lateritic gravel. *Astus subroseus* also occurs in a range of vegetation types, including *Eucalyptus* mallee shrubland, shrubland with emergent *Eucalytus* mallee, and *Eucalyptus* woodland over low open shrubland. (Figure 3A)

Flowering period. Flowering from August to October. Fruits recorded in October. Mature fruits measured on *P.G. Wilson* 5680.

Conservation status. Astus subroseus is quite widespread, but a large part of its known range is located in the wheat belt, where clearing is extensive and environmental degradation ongoing. Searches of some older localities by the authors (Merredin area, Bruce Rock) did not relocate *Astus subroseus* at those places, although the searches were not exhaustive. The authors did locate one new population, but this was quite small. In the wheatbelt part of its range this species is known from three small reserves (Burngup Water Reserve, Wogarl Townsite Reserve and Water Reserve 19014 west of Wyalkatchem). It is likely that in the wheat belt part of its range *Astus subroseus* will be reduced to occurring in such reserves. However, it is also known from the goldfields, although only from three collections. It is probable that the small number of collections from the goldfields indicates lack of collecting, rather than indicating true levels of occurrence.

Etymology. The specific epithet refers to the pink colour of the flowers, which varies from very pale to fairly deep in intensity.

Affinities and notes. This species has previously been known by the informal name *Baeckea* sp. Burngup (*A.M. Coates* 4423). It is very closely related to *A. tetragonus*, differing in its usually smaller leaves with fewer rows of oil glands, its larger and more colourful flowers, and its usually fewer and shorter processes.

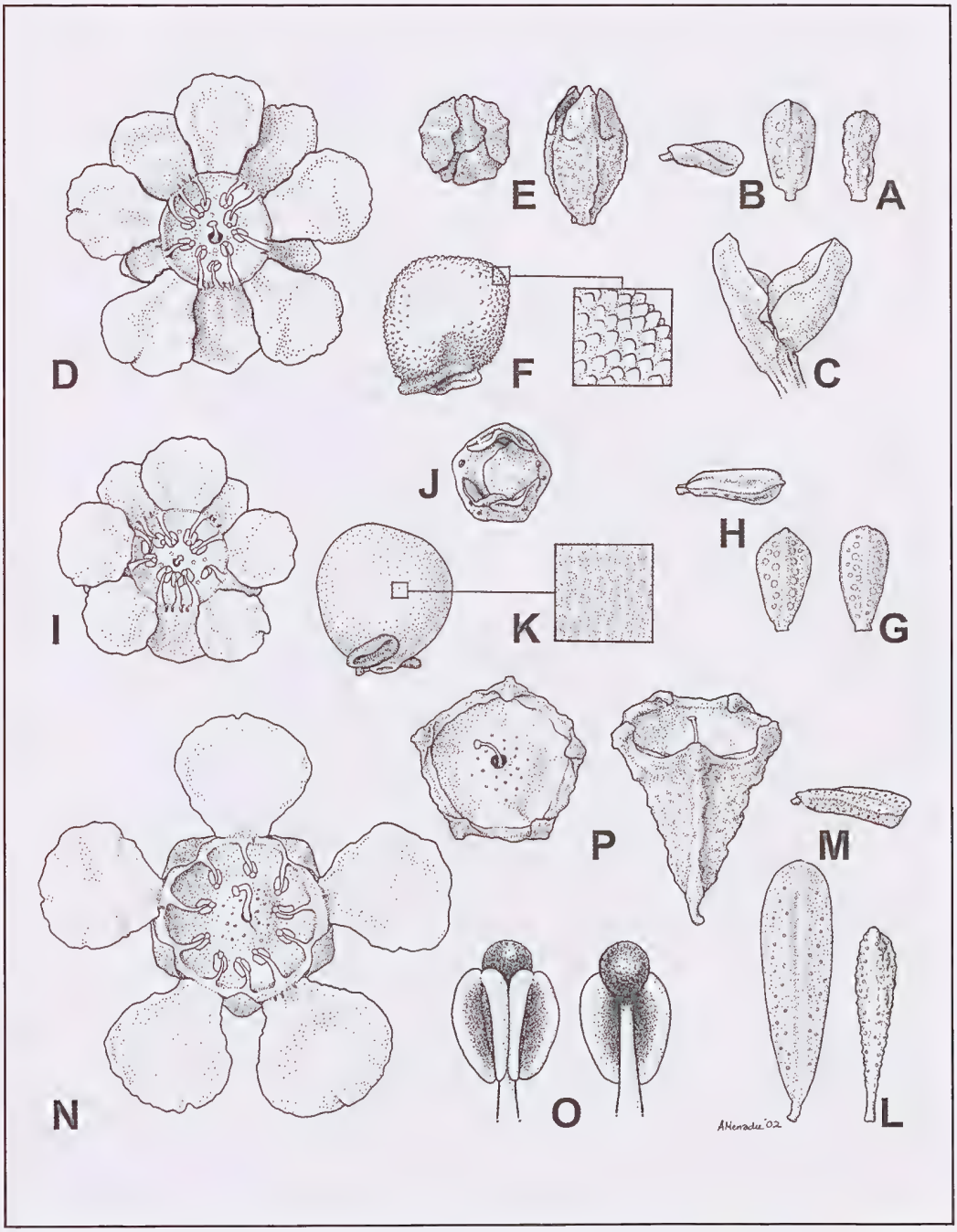

Figure 2. A–F. *Astus subroseus*. A – juvenile leaf (×10), B – two views of adult leaf (×10), C – peduncle and bracteoles (×15), D – flower (×7.5), E – top and side view of fruit (×7.5), F – insect-galled seed (×20); G–K. *Astus tetragonus*. G – juvenile leaf (×10), H – two views of adult leaf (×10), I – flower (×7.5), J – top view of fruit (×10), K – insect-galled seed and chaff pieces (×30); L–P. *Astus wittweri*. L – juvenile leaf (×7.5), M – two views of adult leaf (×7.5), N – flower (×7.5), O – two views of stamen (×50), P – top and side view of young fruit (×8). Drawn by Annemarie Menadue from *A.M. Coates* 4423 (A–D), *Paul G. Wilson* 5680 (E,F), *R. Spjut et al.* 7333 (G–I), *R.J. Hnatiuk* 761163 (J,K), *A.S. George* 16135 (L–O) and *M.G. Brooker* 3722 (P).

Astus tetragonus (F. Muell. ex Benth.) Trudgen & Rye, *comb. nov.*

Baeckea tetragona F. Muell. ex Benth., Fl. Austral. 3, 77 (1867). *Type:* Middle Mt Barren, [Western Australia], *G. Maxwell* (*lecto:* MEL 73059, here designated). *Other material:* Lucky Bay, [Western Australia], January 1802, *R. Brown* (*lectopara:* BM 000603459); east of King George Sound, [Western Australia], 1828–1829, *W. Baxter* (*lectopara: n.v.*).

Illustration. Blackall & Grieve (1980: 70) [as *Baeckea tetragona*]; Rye & Trudgen (2005: Figure 1F).

Dense *shrub*, 0.3–1.5 m tall, with many erect branchlets. *Leaves* moderately spreading, crowded on branchlets; petiole 0.3–1 mm long. *Leaf blades* obovate to broadly elliptic, 1.3–3.2 mm long, 1.0–1.3 mm wide, thick, apex obtuse; abaxial surface with a distinct keel especially towards apex, often produced into a minute subterminal point; abaxial surface with moderately large oil glands usually in 2 or 3 main rows on each side of keel; adaxial surface with less prominent oil glands. *Inflorescence* of 2–5 pairs of flowers clustered at tip of each branchlet or at the base of new growth. *Peduncles* usually 0.6–0.8 mm long. *Bracteoles* persistent, ovate or broadly ovate, with an acute herbaceous keel and broad scarious margins, 0.9–1.5 mm long. *Anthopodium* absent or up to 0.7 mm long. *Buds* with a highly raised apex. *Flowers* 5-merous but apparently 6–8-merous as a result of the combination of the 3 largest and most petaline calyx lobes with the 5 petals, white or possibly rarely very pale pink, 3–5 mm diam. *Hypanthium* obconic to hemispheric, 1.0–2.5 mm long, 1.5–2.5 mm diam., glandular-rugose; free portion *c.* 0.5 mm long. *Calyx lobes* 5, moderately spreading, very unequal, of two intergrading kinds, 1.0–1.2 mm wide, often pink-tinged outside; largest calyx lobe petaline, semi-elliptic, 1.3–1.8 mm long; smallest calyx lobe sepaline, 0.6–1.0 mm long, with a central thickened herbaceous band. *Petals* 5, spreading, scarcely clawed, more or less circular, 1.3–2 mm long. *Androecium* of 8–10 (usually 10) stamens, 1–3 opposite each calyx lobe, with a filament 0.5–1.2 mm long; processes few or many, opposite the calyx lobes, 0.15–0.3 mm long. *Anthers* 0.3–0.5 mm long; connective gland 0.1–0.2 mm diam. *Ovary* 2–4-locular, usually 3-locular, with 1 or 2 loculi reduced, flat-topped; ovules 4–6 in at least one loculus, often 1 or absent in reduced loculi, often 2-toned with a dark-coloured strip adjacent to the placenta. *Style* 0.5–1.5 mm long; stigma peltate, 0.15–0.2 mm diam. *Fruit* very irregularly obconic, *c.* 1.7 mm long, *c.* 1.4 mm wide, apparently flat-topped, without any spongy tissue, 1-seeded as far as known; hypanthium broadly obconic, irregularly swollen on one side or towards base, glandular-rugose and ribbed. Viable seeds (possibly not seen at full maturity) broadly reniform, *c.* 1.2 mm long, *c.* 0.6 mm wide, *c.* 0.65 mm thick, pale brown. *Insect-galled seeds* almost globular, *c.* 0.8 mm long, *c.* 0.6 mm wide, *c.* 0.7 mm thick; testa very pale golden brown, minutely reticulate; hilum small. (Figures 1, 2G–K)

Selected specimens examined. WESTERN AUSTRALIA: Mt Ridley, *K.M. Allen* 365 (CANB, MEL, NSW, P, PERTH); Lake Wagin, 1893, *Miss Cronin* (MEL); Cape Riche, 9 Oct. 1928, *C.A. Gardner* 2148 (PERTH); junction of Fitzgerald and Susetta Rivers, Fitzgerald River National Park, 34°01'S, 119°27'E, 12 July 1970, *A.S. George* 9969 (PERTH); 58 km W of Point Malcolm, 20 Sep. 1976, *R.J. Hnatiuk* 761163 (PERTH); near summit of Mt Burdett, 4 Oct. 1968, *E.N.S. Jackson* 1320 (AD); near East Mt Barren estuary, *G. Maxwell* (BM000603460); Needilup Hill, 16 Aug. 1964, *K.R. Newbey* 1349 (PERTH); Lort River, near crossing of the Esperance–Ravensthorpe road, 9 Oct. 1968, *A.E. Orchard* 1428 (AD, PERTH); on a granite hill N of South Coast Highway, 33.5 km E of Ravensthorpe, 12 Dec. 2003, *B.L. Rye* 231255 (CANB, MEL, PERTH); 115 km ENE of Esperance, 1 Oct. 1970, *R.A. Saffrey* 1250 (AD, CANB, MEL, PERTH); Mt Howick, 29 Apr. 1968, *Paul G. Wilson* 8130 (K, MEL, NSW, PERTH); 2.3 km N of Maringerup Rd, South Coast Highway, 23 Oct. 1997, *Peter G. Wilson* 1435 & *N. Lam* (NSW *n.v.*, UNSW *n.v.*, PERTH); Cape Le Grand, 30 Oct. 1968, *J. Wrigley* 030920 (BRI, CBG, NSW, PERTH).

Distribution and habitat. Endemic to Western Australia, found in a belt along the south coast from Cape Riche to 115 km east-north-east of Esperance and inland to Needilup Hill and Mt Ragged. *Astus tetragonus* is commonly found on granitic rocks over almost all of its range, but at Cape Riche grows on sandstone, and one collection was described as coming from soil with "underlying geology saline and gypsiferous clay and silt in playa lake deposits". This species grows in a variety of soil types, including sandy soil on granite, loam on granite, brown sandy loam and sandy gravel. It also occurs in a range of vegetation types including low open *Eucalyptus* woodland, *Allocasuarina campestris* thicket, and open heath. It often occurs with a variety of granite-associated species. (Figure 3B)

Flowering period. Flowering specimens have been collected from August to early November. Mature fruits observed on *R.J. Hnatiuk* 761163. Seeds measured from *R. Meissner* LB164.

Conservation status. This species has a fairly wide range along the south coast and is found in three large national parks. Its conservation status is probably secure.

Typification. The specimen selected as the lectotype has a corner of the label folded down with the letter B written on the reverse side, indicating that Bentham examined this specimen. One of the two excluded syntypes, cited as "E of King George's Sound, Baxter", was not located in this study.

Affinities. See notes under *Astus subroseus*.

Notes. Normally this species has ten stamens in a circle in groups in the sequence 1,2,3,1,3 with a solitary stamen opposite the centre of each of the two smallest calyx lobes, two lateral stamens opposite the medium-sized calyx lobe and three stamens (one central and two lateral) opposite each of the largest two calyx lobes. A similar arrangement of 10 stamens has been observed in many unrelated species such as *Aluta aspera* Rye & Trudgen (Rye & Trudgen 2000: Figure 3L), *Baeckea elderiana* E. Pritz. and a close relative of *Baeckea robusta* F. Muell. (Rye 1987: Figure 142C), but these taxa show much less variation in calyx lobe size. A few specimens of *A. tetragonus* (e.g. *R.A. Saffrey* 1250) with very small flowers appear to have a variable number of stamens from 8 to 10, those with 9 stamens having the arrangement 1,2,2,1,3 and those with 8 stamens having only 2 stamens opposite each of the inner calyx lobes.

At coastal locations *Astus tetragonus* can occur on headlands facing the ocean, when it is wind-pruned and presumably tolerant to salt carried by the wind. On more sheltered sites on granite hills further inland it can reach 1 metre in height, but still with a dense habit.

Astus wittweri Trudgen & Rye, *sp. nov.*

Asto duomilio affinis sed foliis latioribus, anthopodo et floribus majoribus, et ovulis plus numerosissimis differt.

Typus: Lower part of Mt Ragged, Western Australia, 16 Nov. 1976, *E. Wittwer* W1898 (*holo:* PERTH 06735878; *iso:* KPBG, PERTH 06790127).

Illustration. Rye & Trudgen (2005: Figure 1G).

Shrub 0.5–2 m tall, with short leafy branchlets on long stems. *Leaves* antrorse to almost patent, crowded on the branchlets, separated on lower stems; petiole 0.5–1 mm long; lamina obovate, 2.2–4.2

mm long, 1.2–1.6 mm wide, somewhat thickened but without an obvious keel, apex obtuse, abaxial surface smooth, oil glands abundant on both surfaces and in many rows across the lamina. *Inflorescence* usually of 3–8(15) pairs of flowers clustered at tip of each branchlet. *Peduncles* 0.6–0.9 mm long. *Bracteoles* caducous (present on young buds only), subulate, 1.6–2 mm long, 0.5–0.6 mm wide. *Anthopodium* 1.5–2 mm long. *Buds* 5-lobed around a concave apex. *Flowers* (4)5-merous, 7.5–9 mm diam. *Hypanthium* obconic or broadly obconic, 2–4.5 mm long, 4–5 mm diam., glandular but scarcely rugose; free portion 1–1.4 mm long. *Calyx lobes* (4)5, all of a similar size, very depressed, 0.4–0.5 mm long, 1.5–2 mm wide, strongly incurved at apex, with a very thickened herbaceous keel and scarious lateral margins, the innermost calyx lobe often with the scarious margin extending around the apex. *Petals* (4)5, widely spreading, scarcely clawed, subcircular, 2.5–3.6 mm long, white. *Androecium:* stamens usually 10, one opposite each petal and calyx lobe, rarely 8 (in 4-merous flowers), the antipetalous ones with a filament 0.9–1.0 mm long, the antisepalous ones tending to be shorter, with a filament 0.6–0.9 mm long; processes few, opposite the petals, 0.05–0.2 mm long. *Anthers* 0.4–0.6 mm long; connective gland 0.2–0.4 mm diam. *Ovary* 3(4)-locular, the indehiscent loculus reduced in size; ovules in two valvate loculi 4–7 (usually 6), in non-valvate loculus 1 or rarely 2–4, uniformly coloured or sometimes somewhat 2-toned. *Style* 1.3–2.3 mm long; stigma peltate, 0.3–0.4 mm diam. *Fruit* heart-shaped in outline, *c.* 2.5 x 2.2 mm, with summit prominently 2-lobed, each lobe corresponding with one of the 2 valvate loculi, the non-valvate loculus of a similar volume but more compressed, the remainder of the fruit (at the base and extending up one side) with a very open reticulum of spongy tissue; indehiscent loculus to one side of fruit, its summit reaching the base of the lobes; lobes extending *c.* 0.6 mm above the base of the free part of the hypanthium but deeper at centre of fruit; hypanthium broadly obconic-obovoid, glandular but without obvious ribs when fully mature. *Seeds* reniform-obovoid, (1)1.2–1.6 mm long, *c.* 0.5 mm wide, 0.6–0.7 mm thick, medium brown. (Figure 2L–P)

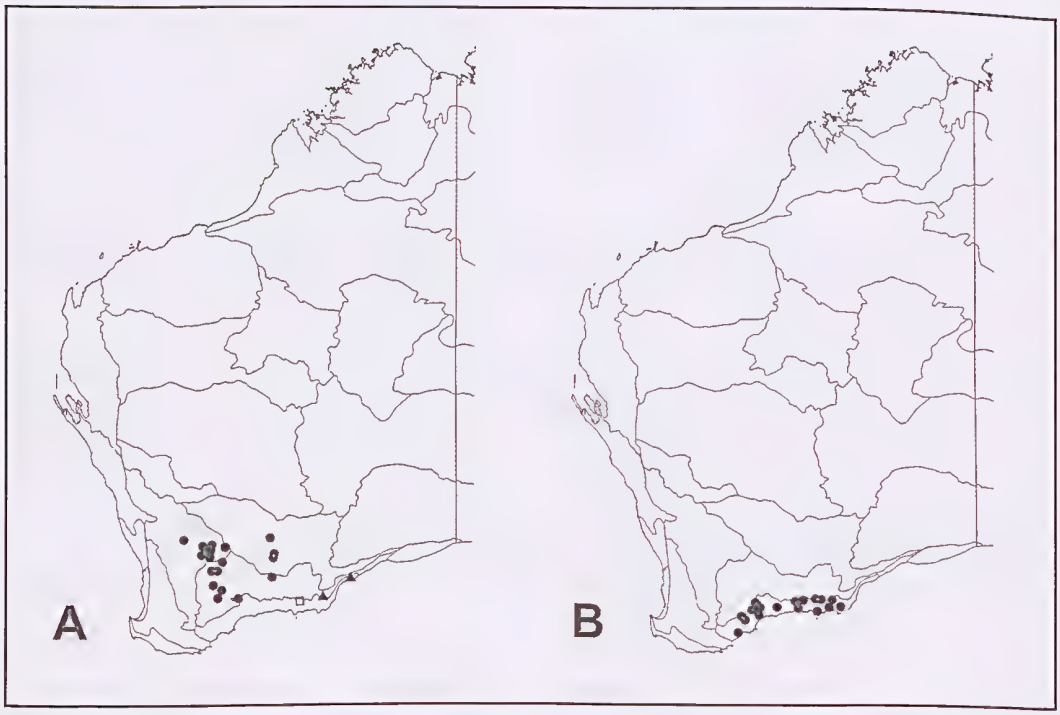

Figure 3. Distribution maps. A – *Astus duomilius* □, *A. subroseus* ● and *A. wittweri* ▲; B – *Astus tetragonus* ●.

Other specimens examined. WESTERN AUSTRALIA: 10 miles [16 km] W of Pt Culver, 30 Oct. 1973, *M.G. Brooker* 3722 (PERTH); Tower Peak [Mt Ragged], 17 Aug. 1980, *A.S. George* 16135 (PERTH); Mt Ragged, near base, 17 Aug. 1980, *M.A. Clements* 2049 (CBG).

Distribution and habitat. Endemic to Western Australia, known from Mt Ragged and near Point Culver. *Astus wittweri* has been recorded on sand at the base of cliffs or among quartzite rocks on the lower slopes of a rocky ridge, in vegetation variously described as 'mallee shrubland with *Eucalyptus tetraptera* dominant', 'mallee' and 'low shrubland'. (Figure 3A)

Flowering period. Flowering recorded from August to mid November. Fruits recorded late October and November. Fruits and seeds measured on *M.G. Brooker* 3722 and *E. Wittwer* W1898.

Conservation status. Conservation Codes for Western Australian Flora: Priority Two. *Astus wittweri* is only known from four collections, three of these in the vicinity of Mount Ragged in Cape Arid National Park, and the other more than 100 km north-east in Nuytsland Nature Reserve. Both areas are apparently well protected but this poorly known species needs to be surveyed to assess its conservation status better.

Etymology. The specific epithet is in honour of Ernst Wittwer, Nurseryman and Superintendent at Kings Park and Botanic Gardens. Ernst collected widely in the State and collected the material used for the type of this species.

Affinities. Astus wittweri has the broadest leaves and largest flowers in the genus. Its seeds are possibly more deeply colliculate than those of the other species, with the numerous cells deeply convex. It is closely related to *A. duomilius*, differing as described under that species.

Notes. Occasionally a few 4-merous flowers are produced. The buds have a flat top with the fleshy keels of the incurved calyx lobes forming a five-pointed crown around the edge. Usually several seeds are produced in each of the dehiscent loculi and a single seed in the indehiscent loculus.

Acknowledgements

We are indebted to the Australian Biological Resources Study for financial support, Paul Wilson for kindly translating the diagnoses into Latin, Peter Wilson for kindly keeping us informed of progress with the molecular studies, Annemarie Menadue for the line illustration and Peter Rye for the photographs. Loans of specimens were made by the curators of AD, BRI, CANB, CBG, MEL and NSW. Bronwyn Keighery compiled draft descriptions of three of the species under an earlier ABRS grant.

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Goodenia pedicellata (Goodeniaceae), a new species from the Pilbara bioregion of Western Australia

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Abstract

Sage, L.W. and Dixon, K.W. *Goodenia pedicellata* (Goodeniaceae), a new species from the Pilbara bioregion of Western Australia. *Nuytsia* 15(3): 513–516 (2005). A new species of conservation priority, *Goodenia pedicellata*, is described, illustrated, mapped and compared with *G. cusackiana* (F. Muell.) Carolin. Surveys are needed to accurately determine the rarity of the species in the wild, currently known only from the holotype location.

Introduction

Goodenia pedicellata is a distinctive new species from the Pilbara bioregion of Western Australia. A perennial plant of unknown fire response, the species is found on rocky clayey soils, favouring exposed sites on the crest of small hills. The species is easily distinguished by its long, retained, ebracteolate pedicels and dense cottony hairs. The silver foliage in a compact rosette-like arrangement of leaves and slender stemmed flowering habit would make the species highly desirable for amenity horticulture.

The discovery of this species brings the number of known *Goodenia* species for the Pilbara bioregion to 28 and 128 for Western Australia.

New species description

Goodenia pedicellata L.W. Sage & K.W. Dixon, *sp. nov.*

Goodeniae cusackianae (F. Muell.) Carolin affinis sed corolla extra pilis strigosis, pagina seminum aculeata et lobis corollae alis ad *c.* 2 mm latis differt.

Typus: Oakover River tributary on hillside in rocky clayey soils [precise locality withheld for conservation purposes], Western Australia, 20 June 2002, *K.W. Dixon* 999 (*holo*: PERTH 06962467; *iso*: CANB).

Perennial herb to 25 cm tall, single stemmed with dense cottony and strigose hairs. *Leaves* in a rosette-like arrangement or cauline but concentrated at distal end, narrowly obovate to narrowly obtrullate, to 50 mm long (including petiole) and 15 mm wide, petiolate, with dense cottony hairs; rapidly narrowing basally; apex acute, ± apiculate; old leaf bases often retained. *Inflorescence* compact, raceme-like; pedicels to *c.* 15 cm long, retained, articulate immediately below ovary, strigose and cottony hairy; bracts leaf-like; bracteoles absent. *Sepals* lanceolate, 3.5 mm long, ± equal, apex acute, adnate for *c.* ¼ of length, with cottony and strigose hairs. *Corolla* yellow with some purple lines, to *c.* 16 mm long, auriculate; tube *c.* 1 mm long; pouch ± as long as ovary; stiff, simple, appressed, strigose hairs outside with two tufts of stiff, simple downward pointing hairs inside near the top of the throat, simple erect hairs on the outside auricle margin. *Abaxial corolla lobes c.* 5 x 2 mm, fused for *c.* 4.5 mm beyond junction with adaxial lobes, apex acute and partially distinct from wings; wings to *c.* 2 mm wide, rounded. *Adaxial corolla lobes c.* 8 x 1.5 mm; auricle *c.* 1.5 x 2.5 mm; wings to *c.* 2 mm wide opposite auricle and *c.* 0.5 mm wide above auricle, rounded, terminating 0.5 mm below apex of the corolla lobe above the auricle. *Stamen* filaments linear, *c.* 3 mm long; anthers ± elliptic, *c.* 2 mm long, mucronulate. *Ovary c.* 4 mm long with strigose and cottony hairs, tapering basally; septum ± as long as locule and cottony hairy over entire surface; ovules *c.* 40 (*c.* 20 in each locule), scattered over the surface of septum. *Style c.* 3.5 mm long, mostly glabrous; indusium ± depressed obovate or almost square in outline, brown, mouth gaping, scattered simple hairs above and below, conspicuous white bristles on upper and lower lips, 0.2 mm long, ± equal in length. *Fruit* (mostly immature seen) ± elliptic, *c.* 6 mm long. *Seeds* flat, *c.* 1.5 x 1.0 mm, aculeate, brown; wing *c.* 0.2 mm wide. (Figure 1)

Other specimens examined. WESTERN AUSTRALIA: Oakover River tributary [precise locality withheld], 20 June 2002, *P. Nikulinsky s.n.* (PERTH).

Distribution. Currently known only from the type location. This locality is found in the Pilbara Interim Biogeographic Region of the Eremaean Botanical Province (Thackway & Cresswell 1995; Western Australian Herbarium 1998 onwards). (Figure 2)

Habitat. Open, exposed sites with scattered, sparse shrubs on rocky slopes and crests of low hills.

Phenology. Collected flowering in late June.

Conservation status. Conservation Codes for Western Australian Flora: Priority One. The species is currently known from one population on vacant land. Urgent survey effort is required to determine the true extent of the species. Cattle disturbance is a potential threat and the fire response needs to be examined to determine an appropriate fire management regime.

Etymology. The specific epithet refers to the distinctive long and persistent pedicels.

Notes. Goodenia pedicellata is placed within *Goodenia* subgenus *Goodenia* section *Goodenia* subsection *Ebracteolatae* on the basis of the yellow corolla and the absence of bracteoles and enations.

Appearing to have no known close relatives the species is superficially similar to *G. cusackiana.* It can be distinguished from this species by much longer pedicels, more than twice as many ovules and seeds that are aculeate rather than colliculate.

Figure 1. *Goodenia pedicellata* – photograph of detail from holotype collection (*K.W. Dixon* 999).

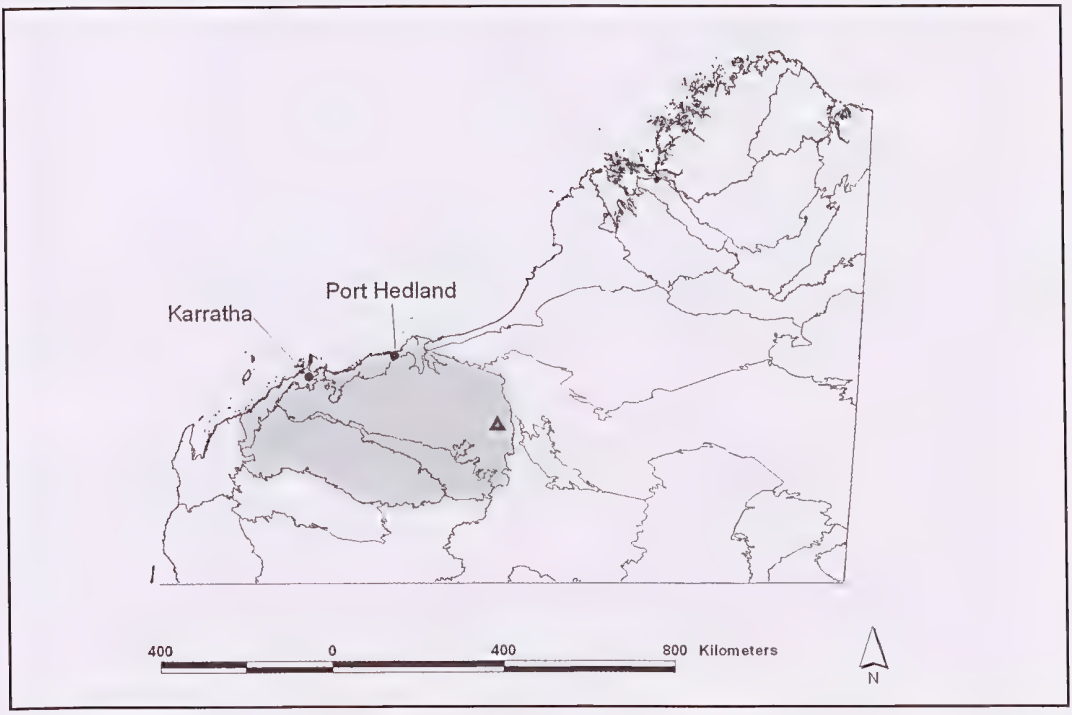

Figure 2. Distribution map for *Goodenia pedicellata* (▲), showing bioregion boundaries (Pilbara bioregion shaded grey).

Amendments to the Flora of Australia Key

The *Goodenia* key in the "Flora of Australia" (Carolin 1992: 149–166), particulary couplet 11 and 12 in Group 8 (p. 164), should be altered as follows:

11: Plant not stoloniferous
12a: Ovary tapering at base
12b: Leaves glabrous or with ± appressed hairs;
south eastern Australia ..... **117. *Goodenia elongata***
12b: Leaves with dense cottony and strigose hairs;
north western Australia ..... ***Goodenia pedicellata***
12a: Ovary rounded at base

Acknowledgements

Thanks to Philippa Nikulinsky for providing material and site information, and thanks to Paul Wilson for providing the Latin diagnosis and nomenclatural advice.

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Rulingia borealis, a new combination based on *R. malvifolia* var. *borealis* (Malvaceae *s.l.* or Sterculiaceae)

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Abstract

Wilkins, C.F. *Rulingia borealis,* a new combination based on *R. malvifolia* var. *borealis* (Malvaceae *s.l.* or Sterculiaceae). *Nuytsia* 15(3): 517–522 (2005). *Rulingia malvifolia* Steetz is an illegitimate name since Steetz, in describing *R. malvifolia* cited *Commersonia cygnorum* Steud. in synonomy. Pritzel (1901) then described *Rulingia malvifolia* var. *borealis* E.Pritz. This variety is here raised to species rank to become *R. borealis* (E.Pritz.) C.F. Wilkins.

Introduction

No comprehensive treatments of *Rulingia* R.Br. or *Commersonia* J.R.Forst. & G.Forst. have been published since Bentham (1863). There are 23 currently recognised species of *Rulingia* in Australia (Hnatiuk 1990) and one in Madagascar, and 11 species of *Commersonia* in Australia (Hnatiuk 1990) with one of these also occurring in SE Asia and islands of the Indo-Pacific. Twenty-two of the 33 species in the two genera occur in Western Australia. Taxonomic confusion between the two genera was manifested by many species being described as *Rulingia* and then placed in *Commersonia* or vice versa, particularly in Mueller's *Systematic Census of Australian Plants* (1882).

There is doubt as to the validity of separating *Commersonia* and *Rulingia. Rulingia* is currently delimited from the earlier described *Commersonia* by having single rather than compound staminodes between the stamens. These genera have recently been shown, by a cladistic analysis of morphological data of the Lasiopetaleae (Wilkins 2002), and studies using *ndh*F molecular data (Whitlock *et al.* 2001), to be paraphyletic. However, only a few species of each genus were included in both analyses and current studies by Wilkins and Whitlock aim to include all species, which would test these results.

Rulingia malvifolia Steetz is one of the species with a history of taxonomic confusion. *Rulingia malvifolia* Steetz is an illegitimate name since Steetz, in describing *R. malvifolia* cited *Commersonia cygnorum* Steud. in synonomy. Steetz described this species in 1848 [as *R. malvaefolia*], basing it on *Commersonia cygnorum* Steud. (1845). In 'Flora Australiensis' Bentham (1863) recorded *C. cygnorum* as a synonym of *R. malvaefolia*, then in 1882, *C. cygnorum* was included by Mueller in his 'Systematic Census of Australian Plants' and *R. malvifolia* was excluded. In 1901 Pritzel incorrectly described *R. malvifolia* var. *borealis* as a variety of *R. malvifolia* rather than of *R. cygnorum.* In 1931 Gardner transferred *C. cygnorum* to *Rulingia* and correctly cited *R. malvifolia* as a synonym. Blackall & Grieve (1956) published a new combination *Rulingia cygnorum* var. *borealis* and cited *Rulingia malvifolia* var. *borealis* in synonomy. This combination was invalid (Article 33.3 ICBN, Greuter *et al.* 2000) as post 1953, a full and direct reference to the author of the basionym and the place of valid publication is required.

Rulingia malvifolia Steetz is incorrectly recorded as a current species in the 'Census of Australian Vascular Plants' (Hnatiuk 1990) and its distribution recorded as W – 'recorded for the Western Australian state but region unknown'. Hnatiuk also includes the current name *Rulingia cygnorum* (Steud.)C.Gardner, but incorrectly lists *R. cygnorum* (Steud.)C.Gardner var. *cygnorum* and *R. cygnorum* var. *borealis* (Steud.)C.Gardner, both of which have never been published.

The Australian Plant Name Index (Australian National Herbarium 2003) gives an accurate list of the three published names and their status. Although validly published, the name *R. malvifolia* var. *borealis* E. Pritz. is not a satisfactory one to use since *R. malvifolia* is illegitimate. In any case this taxon is clearly distinct at the species level and so is raised here to species rank as *Rulingia borealis*.

Methods

Collections from AD, CANB, MEL, NSW and PERTH are included in this study. The species is endemic to WA, has previously been well collected and recently studied across its range by the author. Floral measurements are from re-hydrated herbarium collections and vegetative measurements are from dried specimens. Leaf hair density is defined as 'scattered' when the hairs are well separated, 'medium density' when the hairs are just touching laterally, 'dense' when the hairs are strongly overlapped with the epidermis remaining visible, and 'tomentose' where hair density conceals the epidermis. Fruit measurements include the length of the setae on the outer surfaces.

Taxonomy

Key to differentiate *R. borealis* from *R. cygnorum*

1. Staminodes densely hairy on outer surface, mature leaves ovate to broadly-ovate, abaxial leaf surface with scattered to medium density stellate hairs, fruit bristles with stalked, clavate glands along length, grows on granite (Bickley to Cape le Grande) ..... **R. cygnorum**
1. Staminodes glabrous, mature leaves narrowly-ovate, ovate or oblong, abaxial leaf surface with a dense tomentum of stellate hairs, fruit bristles with stellate hairs along length and glands absent, grows on limestone (Seabird to Shark Bay and Dirk Hartog Island) ..... **R. borealis**

Rulingia borealis (E.Pritz.) C.F.Wilkins, *comb. et stat. nov.*

Rulingia malvifolia var. *borealis* E.Pritz. in F.L.E. Diels & E. Pritzel, *Botanische Jahrbücher* 35: 369 (6 Dec. 1904); *Rulingia cygnorum* var. *borealis* (E.Pritz.)W.E.Blackall & B.J.Grieve, *How to Know Western Australian Wildflowers*, part 2: 355 (1956), *nom. invalid.*

Typus: 'District Swan: in collibus calcareis prope mare', E.Pritzel Pl. Austr. occ. 431, July 1901, *lecto* (here designated): M 0067106; *isolecto* (here designated): AD 98015068, B 100124772, W. *Other material:* 'Hab. in distr. Irwin pr. Champion Bay in dunis arenoso-calcareis in umbra fruticetorum, D.3198, flor. m. Junio', *lectopara:* PERTH 01626086.

Illustrations. Blackall & Grieve (1956: 355) and Grieve (1998: 624).

Shrub, clonal stems erect and spreading 0.4–1.5 x 0.4–1.5 m; *young stems* with scattered, short-stalked, white, erect, stellate hairs with pale tan centres 0.5–1.0 mm diam., over a tomentum of sessile, white, stellate hairs 0.2–0.5 mm diam., becoming red-brown or grey, glabrous with longitudinal, fine ridging. *Stipules* persistent, green becoming red-brown, narrowly-lanceolate, irregular margin, 3–5.7 x 0.3–0.7 mm. *Leaf* petiole 1.3–4.5 mm long, hairs as on young stem, base attenuate, blade narrowly-ovate, ovate or oblong, 14–38 x 7–20 mm; adaxial surface with medium density to tomentose, sessile, white, 6 -armed, erect, stellate hairs to 0.6 mm diam.; abaxial surface dense to tomentose, sessile, white, 12 -armed, erect, stellate hairs 0.6–1.0 mm diam.; margin irregularly crenate, with crenate lobes recurved, apex obtuse. *Inflorescence* a leaf-opposed cyme, 9.8–14 mm long, flowers 7–12. *Bud* base attenuate and apex acute. *Peduncle* 1.5–3 mm long. *Pedicel* 2–5.5 mm long. Peduncle and pedicel with dense, sessile, 12 -armed, white, stellate hairs to 0.5 mm diam. *Bract* towards base of pedicel, narrowly-elliptic, green becoming red-brown, 1.8–4 x 0.2–0.3 mm, inner surface with scattered 1–3 armed appressed, hairs, to 0.4 mm long, outer surface with medium density, 1–3 armed, appressed hairs, 0.7 mm long, margin irregular. *Calyx* white, 3.9–6.8 mm long, tube *c.* 1/4 of total calyx length, lobe ovate, *c.* 2.9–6.0 x 1.3–2.1 mm, apex acute; adaxial surface base green, centre and margin of lobes with scattered, 1–3 armed, appressed hairs, to 0.15 mm diam.; abaxial surface base with medium density, sessile, stalked, white, erect, stellate hairs to 0.5 mm diam., with dark brown centres, over smaller, sessile, white stellate hairs to 0.2 mm diam., towards apex with similar but scattered stellate hairs. *Petals* glabrous, cream, 3.4–4.7 x 1.0–1.5 mm, base incurved around stamen but not gibbous, ovate; apex a linear yellow or cream ligule 2.7–3.7 x 0.25–0.3 mm. *Staminal tube* glabrous, 0.1–0.3 mm long. *Staminodes* white, glabrous, ovate to narrowly-ovate, 1.7–2.3 x 0.7–0.8 mm. *Filaments* white, glabrous, 0.5–0.8 x 0.1–0.2 mm. *Anthers* dark red, broadly elliptic, *c.* 0.7 x 0.3 mm, ventri-fixed, latrorse slits. *Ovary* five celled, globose *c.* 0.6 x 0.7 mm, cells fused laterally with no indentation and fused at the central axis, outer surface green with pre setae outgrowths. *Ovules* 3 per cell. *Styles* five, 0.4–0.5 mm long, glabrous, free at base, fused at prominently capitate stigmas. *Fruit* globose, brown, chartaceous, 4.5–9.0 x 7–11.0 mm, spiky appearance from brown, stiff, setae to 2.8–3.5 mm long, with stiff, white, stellate hairs on apex and scattered along complete length of seta, over dense, soft, white stellate hairs on outer surface of fruit. *Seed* dark brown, glabrous, with longitudinal, fine ridging, 1.3–1.5 x 0.8–0.95 mm. *Aril* a yellow, translucent cap *c.* 0.7 x 0.7mm.

Specimens examined. WESTERN AUSTRALIA: Greenough, 20 Jul. 1965, *A.M. Ashby* 1516 (AD, PERTH); Goat Gulch, Kalbarri National Park, 22 July 1998, *D. & B. Bellairs* 5002 (PERTH); Hutt Lagoon, 30 Aug. 1983, *R.J. Cranfield* 3099 (PERTH); 6.5 km N of Arrowsmith Siding along Brand Hwy, 2 July 1992, *R.J. Cranfield & P.J. Spencer* 8264 (CANB, PERTH); Brand Hwy, 0.9 km S of Leeman turnoff, 18 June 1997, *R. Davis* 3354 (PERTH); 9.6 km SSE along Kalis Street from Port Denison, Dongara, alternative route, 18 July 2001, *R. Davis* 9840 (PERTH); WA, *s. dat.*, *WV Fitzgerald s.n.* (NSW); *Ca.* 3.8 km WSW of Louisa Bay Well, Dirk Hartog Island, 4 Sep. 1972, *A.S. George* 11524 (PERTH); Road to Pinnacles, Nambung National Park (Reserve 28393), 1 Nov. 1991, *E.A. Griffin* 6671 (PERTH); Zuytdorp National Park, 1.6 km from coast on track to Zuytdorp wreck site, 18 Aug. 1995, *G.J. Keighery & N. Gibson* 856 (PERTH); Kalbarri National Park, beside old vermin fence on S boundary, 6 Aug. 1996, *G.J. Keighery & N. Gibson* 2071 (MEL, PERTH); 4 km S Seabird 22 June 1992, *G.J. Keighery* 12481 (PERTH); Steep Point, Shark Bay. Approximately 8.5 km SE of Mt Direction, 22 Sep. 1997, *A. Markey* 1637 (PERTH); Greenough Front Flats (S), Henry Rd E of railway line, Greenough Hamlet, 11 Aug. 1998, *M.H. O'Connor* MOC 0185 (PERTH); 19 miles from Dongara towards Eneabba, 22 Sep. 1968, *M.E. Phillips* 1424 (CANB, PERTH); Beekeepers Reserve Collection, 30 July 1985, *R.T. Wills* RTW 629 (PERTH); 800 m from Horrocks Beach on S side of Horrocks Beach Rd, 31 July 2003, *C.F. Wilkins, M.Trudgen, B. Moyle* CW 1675 (PERTH); 20 m from Cliff Head Rd on Indian Ocean Drive, 1 Aug. 2003, *C.F. Wilkins, M.Trudgen, B. Moyle,* CW 1688 (PERTH).

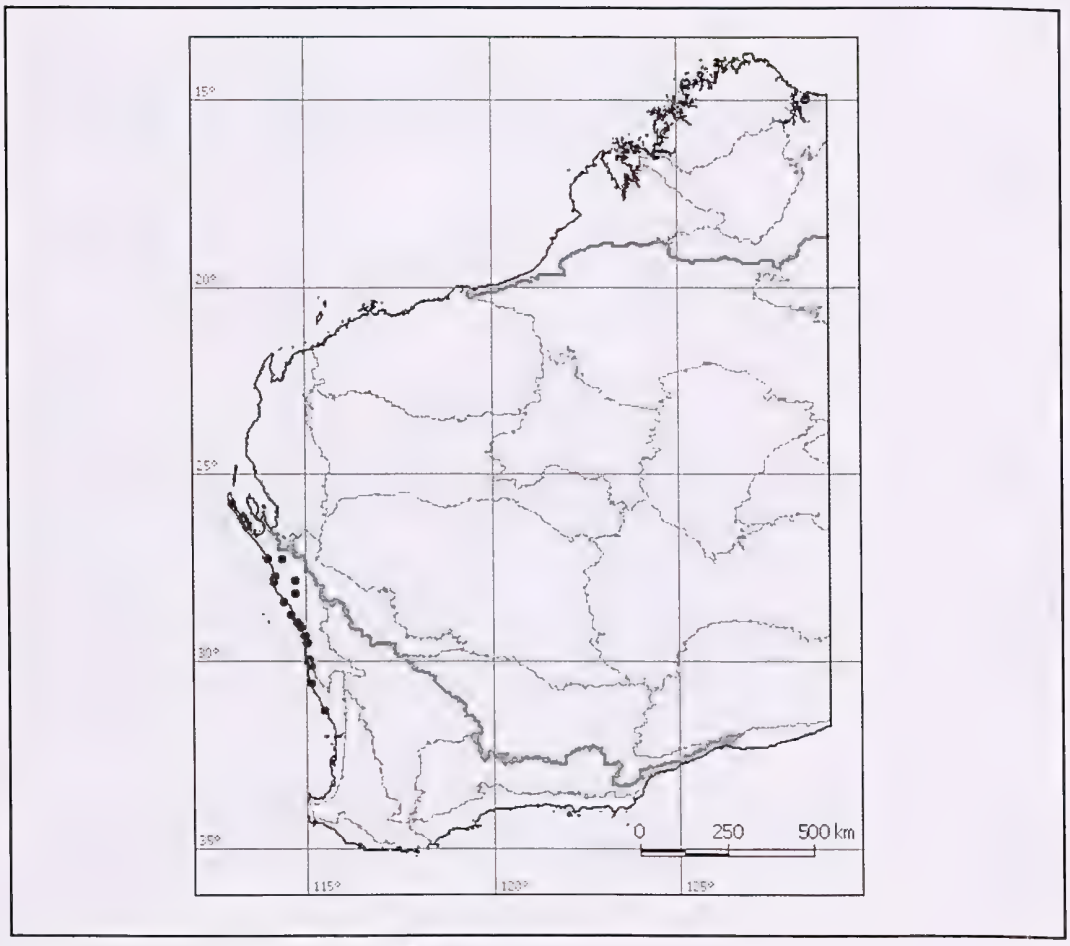

Figure 1. Distribution of *Rulingia borealis* ●.

Distribution. Rulingia borealis occurs along the coast north of Perth, from Seabird to Shark Bay and Dirk Hartog Island. (Figure 1)

Habitat. This species grows on yellow to brown calcareous sand or loam over limestone, in coastal shrubland, open woodland or heath.

Flowering period. Flowers from July to November.

Affinity. Rulingia borealis appears to be most closely related to *R. cygnorum,* from which it differs in having staminodes that are glabrous, rather than densely stellate hairy on the outer surface, leaves that are narrowly-ovate, ovate or oblong, rather than ovate or broadly-ovate, and in having the abaxial leaf surface with dense to tomentose stellate hairs, rather than scattered to medium density.

Similarities between these two species include flowers with white, narrowly-ovate calyx lobes with an acute apex and petals with linear ligules that extend as long as, or longer than the apex of the calyx lobes. Another similarity is fruits with stiff dark brown long bristles on the outer surface, however the

bristles of *R. cygnorum* have stalked clavate glands present along their length; these are absent from *R. borealis*.

Conservation status. This species is mainly recorded as frequent in the area of collection and is not considered to be at risk at this time. The plants are, however, clonal and the plant stems in the area may be from a single plant.

Etymology. The species epithet *borealis* refers to the northern distribution of this species.

Typification. Syntypes of *Rulingia malvifolia* var. *borealis,* E.Pritzel Pl. Austr. occ. 431, 'District Swan: in collibus calcareis prope mare, VII 1901' have been viewed as loaned specimens from AD, M and W, and as a digital image on the website of the Berlin herbarium (B). The Botanische Staatssammlung München (M) specimen has been here lectotypified as it has been annotated as determined by Pritzel as *R. malvifolia* var. *borealis*. The other syntype of *Rulingia malvifolia* var. *borealis*, mentioned in the protologue is *L. Diels* 3198, 'Prope Champion Bay in dunis arenoso-calcareis in umbra fruticetorum'. This specimen has been viewed at PERTH. It is labelled as 'ex Museo botanico Berolinensi', however, is here lectoparatypified as there is more available material of *Pritzel* 431.

Steetz cited *Commersonia cygnorum* Steud. in synonomy with *R. malvifolia.* A type specimen of *C. cygnorum*, Preiss 1642, has been traced at Lund herbarium. Although this specimen has not been viewed by the author, the locality of this Preiss collection 'Ad caput fluvii Cygnorum' has been proposed by Marchant (1990) as being from Millendon near Guildford. This habitat would suggest *C. cygnorum* Steud. is the taxon currently determined in herbaria as *R. cygnorum.* This latter species ranges from Helena Valley to Esperance WA in granite habitats while *R. borealis* grows north of Perth on coastal calcareous sand over limestone. *R borealis* does not match the Drummond collections 72 (BM, W) and 374 (W) which are syntypes for the superfluous *R. malvifolia nom. illeg.* These Drummond type collections match specimens currently accepted in herbaria to be *R. cygnorum.*

Acknowledgements

Thanks are extended to the directors and staff of the herbaria from which loans, images or specialist assistance was received. Sincere thanks to Paul Wilson, Barbara Rye and Alex Chapman for helpful comments on typification and the manuscript, to ABRS for research funding, to the director and staff of PERTH and to the School of Plant Biology at the University of Western Australia for additional assistance and provision of facilities. Fieldwork assistance and companionship from Malcolm Trudgen and Brian Moyle, and collection of material by Cate Tauss, are much appreciated. The excellent photographs of *Rulingia malvifolia* material that were taken by Juliet Wege while at Vienna Herbarium, have been of great assistance to this research project. Provision of the species distribution map by Paul Gioia is much appreciated.

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Short Communication

New and noteworthy plant species recognised as naturalised in Western Australia

The format of this paper follows that of Heenan *et al.* (2002) for New Zealand and Hosking *et al.* (2003) for New South Wales. Species are grouped under Monocotyledons or Dicotyledons, then listed aphabetically by family and scientific name, common name (when available), the location of a taxon description, natural region where the weed has been recorded following the Interim Biogeographic Regionalisation for Australia (Thackway & Cresswell 1995), habitats, first records and area of origin.

MONOCOTYLEDONS

ANTHERICACEAE ***Chlorophytum comosum* (Thunb.) Jacques** **Spider Plant**

DESCRIPTION: See McCune and Hardin (1993).

DISTRIBUTION: Jarrah Forest and Warren IBRA Regions.

HABITATS: Plants have established from discarded garden refuse spreading by plantlets and seed in this area and subsequently spread into the adjacent burnt and disturbed Karri - Marri Forest.

FIRST RECORD: Heights above Turner's Hut, Augusta, 13 Jan. 2004, *G.J. Keighery* 16627 (PERTH 06737536).

REGION OF ORIGIN: South-eastern Africa.

NOTES: The species is occasionally seen as casual on refuse sites and highly disturbed creeklines, for example at Wellington Mills, SE of Collie.

IRIDACEAE ***Dietes grandiflora* N.E. Br.** **Wild Iris**

DESCRIPTION: See Goldblatt (1981).

DISTRIBUTION: Jarrah Forest IBRA Region.

HABITATS: Naturalised in an old sandpit. Plants have established in this area and subsequently spread into the adjacent burnt and disturbed Jarrah - Marri Forest.

FIRST RECORD: Kalamunda, *G.J. & B.J. Keighery* 201.

REGION OF ORIGIN: Southern Africa.

NOTES: The genus *Dietes* Salisb. ex Klatt (Iridaceae) contains 5 species in southern and eastern Africa

and the remarkably disjunct *D. robinsoniana* on Lord Howe Island (Goldblatt 1981 and Green 1994). All members are highly floriferous perennial herbs. In Western Australia *Dietes bicolor* (Steud.) Sw.ex Klatt and *D. grandiflora* N.E. Br. are used extensively as bedding plants in new suburban developments and as roadverge plantings throughout the city and suburbs, and excess materials (prunings, poor plants and seed heads, the species sets copious amount of seed) are often carelessly disposed of. *Dietes iridioides* (L.) Sweet ex Klatt was once a common garden plant in Perth, but has largely been supplanted by the previous species in the past decade.

There are few records of *Dietes* as naturalised plants in Australia. No species are listed in the Flora of Australia treatment by Cooke (1986), nor in the regional floras of Victoria (Conn 1994) or New South Wales (James and Brown, 1993). Scott and Delfosse (1992) do not list *Dietes* in their review of South African Plants naturalised in Australia. Groves *et al* (2000), however, record *Dietes robinsoniana* (C. Moore & F. Muell.) Klatt as naturalised in New South Wales and *D. iridioides* as naturalised in Queensland. *Dietes* is not mentioned in either the Australian (Csurhes and Edwards 1998) or Western Australian (Keighery 1999) lists of potential environmental weeds.

While it is unlikely that *Dietes* will become established in the older western and central areas of Perth with their deep sandy freely draining soils, it could more readily naturalise from plantings adjacent to bushland in the Forest areas on the eastern margins of Perth and around towns in the higher rainfall areas south of Perth. *Dietes*, as a genus, rates highly as an environmental weed risk in the AQIS Weed Risk Assessment System (Pheloung 1995 and Walton *et al.* 1998) and would be unlikely to be approved for importation for its current use. This species should not be used as a major planting feature in areas noted above, especially adjacent to bushland. Alternatively a seed-sterile form should be selected and grown.

Dietes grandiflora is an example of a garden escape in the early stages of naturalisation. Care now in the use of this genus in landscape planting and the correct disposal of material from these plantings should prevent it becoming an environmental weed of the future. At least, this species should be considered and listed as a potential environmental weed.

IRIDACEAE ***Iris laevigata* Fisch.** **Water Iris**

DESCRIPTION: See Matthews (1989).

DISTRIBUTION: Jarrah Forest IBRA Region.

HABITATS: in fringing *Baumea articulata* sedgeland in Lake Nature Reserve west of Albany.

FIRST RECORD: Lake Powell Nature Reserve, near Elleker, 24 Oct. 2002, *G.J. & B.J. Keighery* 175 (PERTH 06330096).

REGION OF ORIGIN: Southern Africa.

NOTES: The genus *Iris* is a large genus of northern hemisphere perennial herbs, many species of which are commonly cultivated in Australia. There are few records of *Iris* as naturalised plants in Australia. Three species are listed in the Flora of Australia treatment by Cooke (1986), *Iris germanica*, L., *I. foetidissima* L.and *I. ungicularis* Poret. In southern Western Australia *Iris germanica* is a scattered

garden escape, where it is largely represented by a clonal white flowered form that does not set seed. *Iris ungicularis* is known from scattered plants on disturbed granite slopes on Mount Melville in Albany. Both of these species are very minor environmental weeds.

The naturalised populations of *Iris laevigata* were spreading via rampant rhizomes but were also setting copious fertile seed. The species probably entered the lake via material being disposed of, or in floods along the Elleker Drain. This species and the other related Water Irises are becoming popular feature plants and have the capacity to invade freshwater lakes and rivers in southern Western Australia.

MUSACEAE ***Musa acuminata* Cholla** **Banana**

DESCRIPTION: See Ross (1987).

DISTRIBUTION: Swan Coastal Plain IBRA Region.

HABITATS: Naturalised along a fresh water seep alongside the Canning River.

FIRST RECORD: Yagan Wetland Reserve, Bull Creek, City of Canning, 6 Dec. 2003, *G.J. & B.J. Keighery* 245 (PERTH 06748872).

REGION OF ORIGIN: South-east Asia.

NOTES: *Musa acuminata* has persisted in a series of freshwater seeps along the Swan River at Bayswater and around an artesian bore on Garden Island. As far as I am aware, these populations have either been removed for rehabilitation purposes (Bayswater), or died when the water overflow was turned off (Garden Island).

The population in Yagan Reserve spread via rhizome expansion along a freshwater seepage line under a tall *Melauca rhaphiophylla* woodland forming a dense monospecific understorey. During 1996–7 C.R.R.E.P.A. (Canning River Residents Environmental Protection Association) members removed large numbers of plants which were supplied to Perth Zoo as feed for Elephants. All plants have now been removed. Although this activity was documented in the Association's newsletter, its presence as a naturalised species and its removal is worthy of record.

DICOTYLEDONS

AIZOACEAE ***Delosperma ?vinaceum* L. Bolus**

DESCRIPTION: See Herre (1971).

DISTRIBUTION: Geraldton Sandplains IBRA Region.

HABITATS: Low *Nitraria* shrubland on shallow soils over limestone.

FIRST RECORD: Rat Island, Abrolhos Islands, 5 Dec. 2000, *G.J. Keighery* 16023 (PERTH 06226442).

REGION OF ORIGIN: Southern Africa.

NOTES: Material of this species was collected when sterile and grown on in Perth, flowering in summer. The collection was referrable to the large Southern African genus *Delosperma*, however, it did not fruit in Perth and it can only be provisionally placed into a species at present. Two unidentified species of *Delosperma* are listed as naturalised in New Zealand (Webb *et al.* 1988). This species is able to spread rapidly and establish large populations because it roots at the nodes and easily fragments. It should be eradicated from its known occurrence before it is spread elsewhere in the Abrolhos.

CARYOPHYLLACEAE ***Cerastium comatum* Desv.** **Levantine Mouse-ear Chickweed**

DESCRIPTION: See Adams (1996).

DISTRIBUTION: Jarrah Forest and Avon-Wheatbelt IBRA Regions.

HABITATS: Firebreaks, grazed paddocks and Wandoo woodland.

FIRST RECORD: Hillman Nature Reserve (near Darkan), 4 Oct. 1999, *G.J. Keighery & N. Gibson* 4952 (PERTH 6847587).

REGION OF ORIGIN: Europe.

NOTES: This species has previously only been recorded in Australia from six localities in Victoria (Adams 1996), but is obviously well established in the central wheatbelt of Western Australia.

CARYOPHYLLACEAE ***Silene longicaulis* Pourr. Ex Lag.** **Portuguese Catchfly**

DESCRIPTION: See Adams (1996).

DISTRIBUTION: Mallee and Esperance Sandplain IBRA Regions.

HABITATS: During the Biological Survey of the Agricultural Zone this species has been occasionally recorded in disturbed wetlands and at the edges of salt-affected wetlands.

FIRST RECORD: Southern margin of Truslove Nature Reserve, *G.J. Keighery* 16351.

REGION OF ORIGIN: Southern Africa.

NOTES: This species has previously been recorded in Australia from Victoria and South Australia (Adams 1996), but is also well established in the central wheatbelt of Western Australia.

Acknowledgments

Barbara Rowley and Jeanette Mackintosh of the Wildflower Society of Western Australia alerted the author to the naturalising population of *Dietes grandiflora*.

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Corrections to Nuytsia 15(2)

On page 222, the description of the style of *Ptilotus chrysocomus* should read "*Style* sigmoid" and this latter term deleted from the end of the sentence. Also, in Etymology, the description of tepal indumentum should read "of gold–coloured hairs".

On page 226, the stipe measurement for *Ptilotus halophilus* should read "0.8–1 mm long."

CONSERVATION CODES FOR WESTERN AUSTRALIAN FLORA

R: Declared Rare Flora – Extant Taxa (= Threatened Flora = Endangered + Vulnerable)
Taxa which have been adequately searched for, and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection, and have been gazetted as such, following approval by the Minister for the Environment, after recommendation by the State's Threatened Species Scientific Committee.

X: Declared Rare Flora – Presumed Extinct Taxa
Taxa which have not been collected, or otherwise verified, over the past 50 years despite thorough searhcing, or of which all known wild populations have been destroyed more recently, and have been gazetted as such, following approval by the Minister for Environment, after recommendation by the State's threatened Species Scientific Committee.

1: Priority One – Poorly Known Taxa
Taxa which are known from one or a few (generally <5) populations which are under threat, either due to small population size, or being on lands under immediate threat, e.g. road verges, urban areas, farmland, active mineral leases, etc., or the plants are under threat, e.g. from disease, grazing by feral aniamls, etc. May include taxa with threatened populations on protected lands. Such taxa are under consideration for declaration as 'rare flora', but are in urgent need of further survey.

2: Priority Two – Poorly Known Taxa
Taxa which are known from one or a few (generally <5) populations, at least some of which are not believed to be under immediate threat (i.e. not currently endangered). Such taxa are under consideration for declaration as 'rare flora', but are in urgent need of further survey.

3: Priority Three – Poorly Known Taxa
Taxa which are known from several populations, at least some of which are not believed tobe under immediate threat (i.e. not currently endangered). Such taxa are under consideration for declaration as 'rare flora', but are in need of further survey.

4: Priority Four – Rare Taxa
Taxa which are considered to have been adequately surveyed and which, whilst being rare (in Australia), are not currently threatened by any identifiable factors. These taxa require monitoring every 5–10 years.

Publication date for Nuytsia 15 Number 2: 16 December 2004

Short Communication

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ISSN 0085-4417
Print Post Approved PP665002/00003